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UNITED STATES ATOMIC ENERGY COMMISSION

Nuclear Science Abstracts

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September 15, 1948

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NUCLEAR SCIENCE ABSTRACTS

Volume I Number 5

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ADSORPTION AND SCATTERING OF RADIATION

728 Range Measurements of 200 Mev Deuterons in Various Materials, by Walter J. Stephan and R. L. Thornton. AECD-2147 (BP-147), October 20, 1947, decl. November 14, 1947. 14 p. For publication in Physical Review.

The range in aluminum of the deuterons accelerated by the 184-inch cyclotron has been measured. The energy deduced from range-energy curves is 196 Mev which is in excellent agreement with the expected value. Range measurements at the same energy have also been made for Be, C, Cu, Mo, Ag, Sn, Pb, and U. These results agree well with as yet unpublished theoretical curves prepared in this laboratory. Approximate measurements of the energy loss per centimeter path have also been made for these materials relative to aluminum.

ATOMIC POWER

729 Atomic Power and Aircraft Propulsion, by A. Kalitinsky. Society of Automotive Engineers Preprint, June 1948. 25 p.

The development of atomic energy as a source of power will require the aid of the engineering profession, and engineers will need to acquire a knowledge of the atomic sciences. As a first step in this direction, this paper discusses in simple language the structure of the atom, how it is held together, radioactivity controlled release of atomic power, uranium fission, the chain reaction, nuclear fuels, and control and shielding of the reactor. It is explained that for the combination of high performance and long range, atomic propulsion excells all other means. Engineering problems which confront developers of atomic aircraft power plants concern transfer of heat from the reactor to the working fluid, separation of the uranium in the reactor from the working fluid, and reducing the weight of the shielding to confine neutrons and gamma rays. (TDD)

730 Atomic Power for Industry, by H. Etherlington. Machine Design, July 1948. p. 91-97.

This article discusses engineering problems arising in the design of equipment for producing heat and power from nuclear energy. As a background, the nature of the fission process is explained. The types of reactors are described and an indication is given of the requirements to be met by materials of construction, as well as by materials used as fuels and moderators, and for heat exchange, canning, etc. Factors affecting the development of atomic power in the near future are briefly touched upon. (TDD)

731 Atomic Power, What are the Prospects, by M. H. L. Pryce. Bulletin of the Atomic Scientists 4, p. 245-248, August 1948.

The author considers atomic energy in relation to the supply of raw materials, and how long they may be expected to last, and to the time scale of development. The conclusion drawn does not support the optimistic view of atomic power stations in five years, and does not altogether exclude the pessimistic view that it has no important future. It does give hope that in a few decades atomic energy may provide some relief of the fuel shortage. The era of atomic cars, trains and aeroplanes seems unlikely to come about. It is possible that nuclear power may be used in big ships. The production of three fissionable isotopes U^{235}, U^{233}, and P^{239} are briefly discussed. The process of pile breeding is discussed.

ATOMIC POWER

732 Detonation Wave in Nuclear Explosives, by P. Caldirola. Journal of Chemical Physics 16, p. 846-847, August 1948.

The hydrothermodynamic theory is applied in the case where the explosion is determined by means of a chain process of nuclear fission, taking into consideration the effect of pressure on the energy of radiation. The Rankine-Hugoniot curve yields $\bar{C}_v (3/a)^{1/4} p^{1/4} + (7/2) pv \cdot (1/2) pv_1 - q = 0$ where $v = (1/\rho)$ and $v_1 = (1/\rho_1)$.

Evaluating the specific heats of the fission products by considering them as a perfect gas, the hydrodynamic equation can be written as

$$7.25 \times 10^9 p^{\frac{1}{4}} + 3.5pv - 26.7p - 8.4 \times 10^{14} = 0$$

From these equations $p = 9.0 \times 10^{12}$ kg/cm^2, $v = 30.3$ cm^3, $T = 2.4 \times 10^8$ K, $D = 3.3 \times 10^7$ cm/sec, $W = 1.4 \times 10^7$ cm/sec. D is the velocity of the detonation wave, ρ is density, p is pressure, and E is specific internal energy.

BIOLOGICAL EFFECTS OF RADIATION

733 Biological and Photo-Chemical Effects of High Energy, Electrostatically Produced Roentgen Rays and Cathode Rays, by Cecil G. Dunn, William L. Campbell, Harvey Fram, and Ardelia Hutchins. Journal of Applied Physics 19, p. 605-616, July 1948.

The principal portion of the research reported is concerned with the lethal action of X rays produced at high voltages on pure cultures of microorganisms and those found in spices, apple juice, milk, soil, water, and catgut sutures. Some preliminary data on cathode rays are included.

734 Cosmic Radiation and Cancer Mortality, by P. A. Morris, and W. J. Nickerson. Experientia 4, p. 251-255, July 15, 1948.

A collection of data is presented seeking to demonstrate the existence of correlations between fluctuations in the intensity of cosmic radiation and cancer incidence or mortality. Radiation at various locations of geomagnetic latitude and geographic latitude are plotted against cancer mortalities per 10^5 of population.

735 Effect of Deuteron Irradiation of the Skin, by G. Schubert, W. Riezler, and V. Dubrauszky. Strahlentherapie 76, p. 417-424, 1947.

A study was made on guinea pigs to assess the therapeutic value and the danger involved in the use of deuterons. The range of deuterons with an energy of 4 magavolts is 14.1 cm at normal temperature and pressure compared with 2.5 cm for α-particles of the same energy. The strength of the deuteron stream used was about 0.2 to 0.4 microamperes, and the spread in air was about 12 cm the tissue penetration was 0.1 to 0.15 mm.

It was concluded that accidental skin damage from deuterons has a good tending to heal. Also deuterons have therapeutic possibilities, especially in certain skin diseases, but much more preliminary work is necessary.

BIOLOGICAL EFFECTS OF RADIATION

736 Effect of Low Dosage Roentgen Radiation on the Gonadotropic Function of the Hypophysis of the Mature and Immature Female Albino Rat, by John H. Freed, Edmond J. Farris, Douglas P. Murphy, and Eugene P. Pendergrass. Journal of Clinical Endocrinology 8, p. 461-481, June 1948.

Five sexually mature female Wistar albino rats given single doses varying from 100 to 200 r on the third day of their oestrus cycles did not appear to be affected. A second group of 57 rats given single or multiple doses varying from 5 to 300 r on the second day of their oestrus cycles showed no change in running activity or periodicity of the oestrus cycle. Gross anatomical studies and weight determination made of the pituitaries, ovaries, and uteri of 6 of the two-day treated rats and 7 controls showed the pituitary weights of the treated rats to be significantly greater, the uterine weights only slightly greater, and the ovarian weights similar.

Sixteen immature rats given single or 5 successive daily treatments of 5 to 100 r per treatment matured sexually within the normal age limits. In gross appearance and weight their pituitary, ovarian, and uterine organs differed in no way from their control. It is concluded that low dosage radiation produces only a transient effect on the normal pituitary function and has no evident harmful effect. 6 tables. 55 references.

737 The Effect of the Smallest X-Ray Doses, by R. Pape. Wiener Klinische Wochenschrift 60, p. 40, 1948.

738 The Effect of Wave-Length Upon Radio-Lesions Produced in the Mouse, by A. Lacassagne. Atomes et Radiations 1, p. 91-98, 1947.

739 The Effects of X-Rays on the Lymphatic Organs of Normal and Adrenalectromized Rats, by L. Halberstaedter and M. Ickowicz. Radiologia Clinica 16, p. 240-257, 1947.

A series of normal and adrenalectomized rats were irradiated with an X-ray dose of 2000 r. Histologic reactions are reported concerning the pycnotic reaction in thymus, spleen, and mesenterial lymph node within a few hours following the irradiation. It was found that: (a) The greater the volume dose, the stronger the pycnotic reaction. (b) Following irradiation of one part of the body, an indirect influence is demonstrable in the non-irradiated part of the body. (c) Adrenalectomy diminishes the X-ray effect, especially the indirect effect. (d) Thymus, spleen, and mesenteric lymph node do not react to X ray with equal pycnotic intensity, especially if the effect is an indirect one. The thymus shows the greatest sensitivity. This is in conformity with the finding of Dustin, that the thymus generally exhibits a greater degree of susceptibility to toxic substances than either spleen or lymph node.

BIOLOGICAL EFFECTS OF RADIATION

740 Experiments on the Mechanism of the Biological Action of Fast Neutrons Using the Summation Method for Lethal Effects in Mice (with a Section of Dosimetry of Fast Neutrons), by J. S. Mitchell. British Journal of Radiology 20, p. 368-380, 1947.

Adult male mice were individually exposed either to gamma radiation from radium or to a beryllium - polonium neutron source which gave in tissue a dose due to fast neutrons 21 times as great as that due to the associated gamma rays. It is concluded that the 'mixed' radiations applied consecutively are less lethal than comparable doses of either radiation alone, and that this indicates a difference in the mechanism of the biological action of fast neutrons and gamma rays. When the overall time of exposure is 48 hours the relative biological efficiency of neutrons compared with gamma rays, is 32.0 ± 8.6.

It is suggested that the lethal effects of gamma radiations on normal cells are produced, at least in part, by certain types of chromosome interchanges resulting from an intensity dependent 'two hit' process. Possibly, whereas proliferating cells are more sensitive to gamma radiation during a short interval in the prophase stage of mitosis, cells exhibit a much more uniform sensitivity to neutrons throughout both the resting stage and mitosis, because of the greater efficiency of the neutron radiation.

A section deals with the measurement of neutron dose by comparison of the ionization produced in a graphite ionization chamber and a carbon-polystyrene chamber, and the deduction of the corresponding tissue dose. Tables give values of the collision cross sections of H, C, N, and O for neutrons of energy 2.0 to 6.0 Mev and of the fractional energy absorption per unit volume in different media, including water and tissue.

741 Inactivation of Enzyme-Substrate Films by Small Doses of X-Rays, by Daniel Mazia and Gertrude Blumenthal. Proceedings of the National Academy of Sciences 34, p. 328-336, July 1948.

Pepsin-albumin films may be inactivated by small doses of X-rays. Doses of about 100 r produce about 50 per cent inactivation. The sensitivity to radiation depends on the physical configuration of the molecules. It may be varied by surface compression. Calculations suggest that the effects of a single radiation event (ionization or radical production) may be spread to include a large number of enzyme molecules.

742 Intracellular Growth of Bacteriophage Studied by Roentgen Irradiation, by Raymond Latarjet. Journal of General Physiology 31, p. 529-544, July 20, 1948.

Growing Escherichia coli infected with bacteriophage T2 was X-rayed during the 21 minutes latent period which elapses between infection and lysis of the cells. Survival curves of the infected bacteria were determined almost from minute to minute; they disclosed the following facts which are related to the process of phage growth: During the first 7 minutes, the infective virus particle remains in the cell unique and genetically intact. The host cell synthesizes some ultraviolet-absorbing material probably devoted to building future particles. From the 7th to 9th minute the X-ray resistance of the virus particle increases, probably because of some internal change. Then, multiplication starts and is completed at about the 13th minute, when an average of 130 virulent units is present per cell, displaying

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an X-ray resistance twice as high as that of the extracellular virus particle. From 13 minutes to the end, the new units progressively recover the X-ray sensitivity of the extracellular virus. Nothing can be said about either the rate of multiplication between 9 and 13 minutes, or the nature of the multiplying units, except that they are more radiation-resistant (probably smaller) than the extracellular virus. The first steps of the growth process are favored by an unknown component of the lysate, different from the active particles. Several particles can grow in the same host cell.

743 Irradiation of Biological Materials by High Energy Roentgen Rays and Cathode Rays, by J. G. Trump and R. J. Van de Graaff. Journal of Applied Physics 19, p. 599-604, July 1948.

High energy cathode rays and X rays offer a new and effective means of producing biological, bactericidal, and even chemical changes on a practical scale. These changes are brought about by excitation and ionization of constituent atoms of the absorber and need relatively small amounts of ionizing energy. Cathode rays produce similar reaction and can be utilized with several hundred times the efficiency of x-rays. The temperature rise evoked by cancericidal doses of these radiations is about 0.01°C, while complete sterilization of bacteria can be accomplished with ionization doses resulting in a 2°C rise. The constant-potential output of electrostatic accelerators is well suited to quantitative radiation studies and to large-scale sterilization and inactivation processes.

744 Lesions of the Urinary Tract Following Radiotherapy for Carcinoma of the Cervix Uteri, by T. J. D. Lane. British Journal of Urology 20, p. 67-71, June 1948.

This is a review of the literature. Two cases are described in detail and the particulars of a new method of treatment are given. It is noted that complications following the radiation treatment of carcinoma of the cervix mimic the natural progress of the disease itself. As many as 20 per cent of patients apparently cured may show renal or vesical complications. 10 references.

745 Photochemical Processes at the Cell Borders as Primary Processes in Irradiation, by E. H. Graul. Klinische Wochenschrift 24-25, p. 789-791, 1947.

746 Physiological Effects of the Atomic Bomb. Atomes 3, p. 244, July 1948. (In French).

The radiation effects on the survivors of the Nagasaki and Hiroshima bombings are briefly discussed.

BIOLOGY, GENERAL

747 The Measurement of Tissue Dose of Ionizing Radiation. Part I. Beta Ray Emitting Isotopes Uniformly Distributed in a Homogeneous Tissue, by G. Failla, H. H. Rossi, R. K. Clark, and N. Baily. AECD-2142, n.d., decl. December 2, 1947. 11 p. For oral presentation at a Round Table Conference on Units held in Boston, November 30, 1947, and for other informal discussions. Document for sale by AEC.

"Irradiation equilibrium" exists at a point in an absorbing medium when in a small volume surrounding the point, the rate at which energy leaves the boundary is balanced exactly by the rate at which energy enters the small volume, and is absorbed therein. In the case of a beta-ray emitting isotope uniformly distributed in a homogeneous tissue, irradiation equilibrium exists everywhere except in a peripheral layer of thickness equal to the maximum range of the beta rays. Everywhere else in the tissue mass, the energy absorbed per gram of tissue in unit time is equal to the energy liberated by the isotope in one gram of tissue in the same time. Therefore, knowing the number of disintegrations per second occurring in one gram of tissue and the average energy per disintegration, the energy absorbed per gram of tissue may be calculated. Making use of the extrapolation ionization chamber method (Radiology 29, p. 202-215, August 1937) it is also possible, under suitable conditions, to determine the energy absorbed per gram of tissue. A discussion is given of the procedures involved, using P^{32} as a practical case.

748 The Effect of Uranyl-Chloride on the Respiration and Photosynthesis of Chlorella Pyrenoidosa, by Albert W. Frenkel. AECD-2143 (II-188-7446), n.d., decl. November 13, 1947. 8 p. Informal disposition. Document for sale by AEC.

Uranyl-chloride at pH 3.5 - 4.5 was found to inhibit exogenous respiration of glucose by Chlorella by approximately 20 per cent at a uranium concentration of 10^{-4} m/l and 80 per cent at 10^{-3} m/l. No significant inhibition of the endogenous metabolism could be demonstrated. Photosynthesis does not appear to be inhibited in a range of uranium from 10^{-5} to 10^{-2} m/l. Some stimulation was observed which may be due to uranyl sensitized decomposition of organic compounds liberated by Chlorella cells.

749 The Ratio of Amino Acid Nitrogen to Creatinine in the Urine as a Sensitive Test for Uranium Poisoning, by H. Berke and A. Rothstein. AECD-2150 (UR-34), May 25, 1948, decl. July 19, 1948. 44 p. For publication in American Journal of Physiology and in NNES.

Experiments were performed to determine whether amino aciduria could be used as a test of subtle uranium poisoning. The concentration of AAN (amino acid nitrogen) in spot samples of urine of normal rabbits and humans varied considerably although the rate of excretion of AAN was relatively constant. Most of the variation in the AAN concentration resulted from variations in the rate of flow of urine and this could be largely eliminated by using the ratio of AAN to creatinine (C). The AAN/C ratio was as constant as the rate of excretion of AAN, but required only a spot sample of urine rather than a 24-hour sample. The AAN/C ratio proved to be a very useful test for uranium poisoning in rabbits. The minimal dose of U, given as uranyl nitrate, that would elicit a significant response was 0.02 mg per kg of body weight. A proteinuria did not appear until 0.04 to 0.1 mg of U/kg were given. The data for creatinine and AAN concentrations and the AAN/C ratio indicated that the most sensitive response of the

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kidney (at 0.01 mg of U/kg) was a decrease in the rate of urine flow with consequent increases in the concentration of both AAN and creatinine and no change in the AAN/C ratio. At higher levels of U dosage, this picture was followed by an increase in the concentration of AAN and the AAN/C ratio with no further change in the concentration of creatinine.

With repeated intravenous injections of uranyl nitrate in rabbits at 3 to 5 week intervals, certain patterns of response of the AAN/C ratio were observed. The first response was always a marked peak followed by a return to lower but still abnormal values. In general, the magnitude of the response was proportional to the dose of uranyl nitrate given. After subsequent injections, the size of the peak usually diminished or even disappeared but the general level of the ratio remained abnormally high. With large doses of U, however, the ratio tended to become progressively higher with no disappearance of the peaks. The ratio did not return to normal for several months after the last injection even though the kidneys at this time showed no histopathology. The urinary protein tended to show a peak response after each injection followed by a return to normal.

During exposure to inhalation of UO_2F_2 dust, the urinary AAN concentration became elevated after 3 to 5 days, and remained high throughout the rest of the 35-day exposure period. In contrast, the urinary protein, catalase and blood-nonprotein-nitrogen responses were more transient with high levels following the initial insult to the kidney. A return to more normal values followed after about 5 weeks, when regeneration of damaged tubules in the kidney were almost completed. The AAN response is independent of the protein and catalase response, and for this reason the three tests together are more sensitive than any one alone. Some additional evidence is presented bearing on the development of tolerance by the kidney.

750 Tracer Studies on the Distribution and Excretion of Uranium in Mice, Rats, and Dogs, by Albert Tannenbaum, Herbert Silverstone, and Janet Koziol. AECD-2167 (CH-3659), October 31, 1946, decl. July 14, 1948. 72 p. For publication in NNES.

The excretion of uranium and distribution of uranium in tissues following injection of uranyl nitrate was studied in mice, rats, and dogs. Highly radioactive isotopes of uranium were used either as tracers or alone; radioautographs as well as analytical data were obtained. The conclusions of the studies are summarized as follows: (1) A high proportion of the uranium is excreted in the urine within 24 hours after injection. Much smaller proportions are excreted during this period when the dosages are toxic. (2) Initially fecal excretion of uranium is relatively low, but as the urinary excretion rapidly decreases, the fecal uranium may assume significant proportions. (3) Less than 10% of the injected uranium remains in the body after one month following injection of non-toxic dosages of uranyl nitrate. When the injected dose is toxic as much as 40% may be retained. (4) The kidneys and bones are the principal sites of accumulation (retention) of the injected uranium. A greater proportion is retained in the kidneys with toxic dosages as compared with non-toxic dosages. Other tissues contain much smaller concentrations of uranium. (5) Radioautographs indicate that uranium accumulates in bone almost entirely in the cancellous portion (trabeculae) and endosteum. (6) Similar radioautographic studies on kidney reveal that the cortex is the essential site of accumulation with some tendency for concentration at the cortico-medullary junction. (7) When the uranium at the site of injection has been depleted (or removed entirely) the daily rate of excretion of uranium from the body is of the order of 0.5 to 1.0% of that present in the body.

BIOLOGY, GENERAL

751 The Formation of Malignant Tumors in Mice by Deuteron-Bombarded Methylcholanthrene, by B. F. Barnes, F. C. Freytag, W. M. Garrison, and I. Rosenfeld. Science 108, p. 82, July 23, 1948.

As part of a more general program on the effects of ionizing radiations on the carcinogenic activity of various organic compounds, it has been found that deuteron bombardment of 20-methylcholanthrene produces a product which preliminary data show is more active biologically than the original substance. Mice of the C-57 strain were used in the experiment and injected subcutaneously with various amounts of methylcholanthrene or irradiated methylcholanthrene (unseparated).

The results indicate that there were significant increases in the size of the tumors with the irradiated material when compared with methylcholanthrene. The malignant tumors produced by the irradiated sample and methylcholanthrene were of the same type, fibrosarcoma. In two animals, in addition to the sarcoma, early epidermoid carcinoma was present. The systemic toxic effect of methylcholanthrene was reduced by irradiation when higher concentrations (0.125-0.25 mg) were used.

CHEMISTRY, ANALYTICAL

752 Analytical Chemistry of the Manhattan Project. Chapter XXVI. Beryllium, Magnesium, Calcium, Strontium, Barium, and Radium, by L. W. Neidrach, A. M. Mitchell, and C. J. Rodden. AECD-2159, n.d., decl. July 23, 1948. 41 p. For publication in NNES.

Beryllium and its salts were analyzed for their beryllium content. The determination of magnesium and calcium was chiefly for traces in uranium and its compounds. The determination of barium and strontium was of minor importance. Samples of uranium and radium concentrates and ores were analyzed for their radium content.

The sensitivity of their spectral lines makes spectrographic analysis a very useful method for the determination of traces of beryllium, magnesium, calcium, strontium, and barium. 44 references.

753 Fluoride Studies: Part A. Modified Williams Titration for Microgram Quantities of Fluoride. Part B. The Analysis of Atmospheric Samples for Fluoride Content. Part C. The Determination of Fluoride in Blood; by Frank A. Smith and Dwight E. Gardner. AECD-2161 (UR-36), June 9, 1948, decl. July 2, 1948. 38 p. Part A for publication in Analytical Chemistry, Part B for publication in Journal of Industrial Hygiene and Toxicology, Part C for publication in Journal of Biological Chemistry, and all three parts presented orally at the American Chemical Society meeting in Washington, D. C. Also for publication in NNES.

Modified Williams Titration for Microgram Quantities of Fluoride. The salt-acid-thorium titration of Williams (Analyst 71, p. 175, 1946) for microgram quantities of fluoride was modified to permit a more convenient and rapid neutralization of aliquots for analysis, and to eliminate the cumbersome procedure of preparing a new color standard for each sample titrated. A considerable saving in time and effort is achieved for routine analysis. Comparative results are given for the titration of pure solutions of sodium fluoride, and for the titration of perchloric acid distillates by the modified Williams procedure and by the back-titration technique.

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CHEMISTRY, ANALYTICAL

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The Analysis of Atmospheric Samples for Fluoride Content. Procedures are described for the collection and analysis of industrial and exposure-chamber atmospheric samples for fluoride content. Industrial atmospheric samples are collected in an absorbing medium consisting of equal parts of 0.1 N $NaHCO_3$ and 0.01 N KOH solutions, while exposure chamber samples are collected in 0.005 N KOH solution. Aliquots of the absorbing solution are then analyzed for fluoride content by a modified chrome azurol S titration. Results are given for the analysis of atmospheres containing known quantities of fluoride.

The Determination of Fluoride in Blood. A reproducible, accurate method suitable for the routine determination of fluoride in blood has been developed. The procedure requires a preliminary distillation from concentrated sulfuric acid at 134-137°C, evaporation and ashing of the distillate in the presence of lime, and a final redistillation from perchloric acid. The fluoride content of a suitable aliquot of the distillate is then measured by the modified Williams titration. Results are given for the analysis of blood from several species of normal animals, from dogs fed uranium tetrafluoride, and for the distribution of fluoride between cells and serum.

754 Method for Continuous Fluorine Analysis in Mixtures of Fluorine and Nitrogen, by Leonard Nash. AECD-2158 (A-2188), January 12, 1945, decl. July 1948. 8 p. For publication in Industrial and Engineering Chemistry.

The gas mixture is allowed to flow over heated sodium bromide thus producing exchange of bromine by fluorine. The former is then determined by measurement of the extinction coefficient with a photoelectric colorimeter. The method is satisfactory over the range from 0-20% with a precision of about 0.5%.

755 Photometric Determination of Sodium by Differential Evaluation of Uranium Precipitated as the Streng salt. (Dosage Photometrique du Sodium par Evaluation Differentielle de l'Uranium-Précipité á l'Etat de Sel de Streng), by Maurice Herbain. Bulletin de la Société de Chimie Biologique 30, p. 231-234, March-April 1948. (In French)

A method of determination of sodium is described, based upon the use of the triple acetate of magnesium, uranium and sodium (Streng salt) and upon the color reaction of this salt with potassium ferrocyanide in an acid medium. A brown color is developed which is read on Meunier's electrophotometer, using filter 49 (green).

CHEMISTRY, GENERAL

756 The Preparation and Properties of Alkali Metal Borohydrides, by Henry R. Hoekstra. AECD-2144 (ANL-HDY-253), June 1947, decl. September 19, 1947. 45 p. Submitted to the faculty of the Division of Physical Sciences, University of Chicago, in candidacy for the degree of Doctor of Philosophy. Document for sale by AEC.

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Interpretation of trivalent binary boron compounds as acids and of the alkali metal hydrides as bases in the generalized sense proposed by G. N. Lewis, (Journal of the Franklin Institute 226, p. 293, 1938), has led to the discovery of a series of new reactions involving diborane, methyl borate, the alkali metal hydrides, alkoxides and other related compounds. As a result of these studies, sodium and potassium borohydrides have been isolated for the first time, and several new methods for preparing lithium borohydride have been developed. The new procedures are simpler and more convenient than any hitherto known, and make these compounds readily available for investigation. A method for quantity production of sodium borohydride was developed and is described in this report.

The properties of sodium borohydride, including its stability, heat of formation, heat of hydrolysis, and its solubility in various solvents, are briefly described. The existence of an etherate of lithium borohydride and of an hydrate and an ammoniate of sodium borohydride has been established. The rate of interaction of sodium borohydride with water under varying conditions has been studied to determine the usefulness of this compound in the generation of hydrogen. It has been found that the rate decreases rapidly because of increasing alkalinity of the solution. This difficulty has been overcome by addition either of acidic substances or of catalysts to the solid borohydride. Cobaltous salts are the most effective catalysts thus far found; their action has been shown to be due to the formation of the compound Co_2B which is the actual catalyst.

757 Continuous Purification of Hydrogen and Argon-Hydrogen Gas Mixtures, by Ernest D. Klema. AECD-2157 (LADC-234), January 5, 1945, decl. July 19, 1948. 13 p. Informal disposition. Document for sale by AEC.

A method for the continuous convection-current purification of hydrogen and argon-hydrogen gas mixtures is described. Three substances, magnesium metal, calcium hydride, and titanium hydride, have been used successfully as purifying agents.

The electron-drift velocity in argon-hydrogen mixtures in ion chambers should be high compared to the drift velocity in pure argon; qualitative results obtained show this to be the case.

758 The Existence of a Proactinium Valence Less than 5, by Moise Haissinsky and George Bouissières. Comptes Rendus 226, p. 573-574, 1948. (In French).

Experiments were conducted which tend to confirm the existence of Pa of valence less than 5. Pa^{V} forms a fluoride which is easily soluble in very dilute acid, while the fluorides of its neighbors Th^{IV}, U^{IV}, and Act^{III} are not. Therefore, the coprecipitation of Pa with LaF_3 in the presence of Zr fluoride is a definite indication of change of valence of the element. Studies of the properties of the new valence state of Pa are being continued.

CHEMISTRY, GENERAL

759 The Synthesis of DL-Lysine with C^{14} in the Epsilon Position, by Paul Olynyk, David B. Camp, Arvon M. Griffith, Siegfried Woislowski, R. W. Helmkamp. Journal of Organic Chemistry 13, p. 465-470, July 1948.

Improvements in the Fischer and Weigert synthesis of DL-Lysine (Berichte der Deutschen Gesellschaft 35, p. 3772, 1902) are described. DL-Lysine with C^{14} in the epsilon position has been prepared by this modified procedure.

760 The Synthesis of Phenanthrene-9-C^{14}, by Clair J. Collins. Journal of the American Chemical Society 70, p. 2418-2420, July 1948. (See also MDDC-1509).

Florene has been converted to 9-fluorene-carboxylic acid-10-C^{14} by carbonation of 9-fluorenesodium with carbon dioxide-C^{14}. Lithium aluminum hydride reduction of the methyl ester yielded 9-fluorene-methanol-10-C^{14}. Dehydration of the latter compound with phosphorus pentoxide was accompanied by a Wagner rearrangement to form the desired phenanthrene-9-C^{14}. The over-all yields, based on barium carbonate, were 50-55 per cent.

COSMIC RADIATION

761 Interpretation of Cosmic-Ray Phenomena, by Bruno Rossi. Reviews of Modern Physics 20, p. 537-583, July 1948.

Some of the fundamental experiments with cosmic rays are described and an attempt is made to place their results into a logically consistent picture. Short comprehensive discussions are presented under the following headings:

I. Some Quantitative Data on Cosmic Rays: Definitions; the hard and the soft components at sea level and at geomagnetic latitudes greater than 45°; variation of the hard and soft components with altitude at geomagnetic latitudes greater than 45°; the hard and the soft components near the equator; the momentum spectrum of mesons at sea level; slow mesons at various altitudes.

II. Transformations of Cosmic Rays: General consideration; the disappearance of mesons; the products of the disappearance of mesons; interactions of mesons with matter; stars and penetrating showers; ionization bursts; protons, α-particles, and neutrons of low energy; production of electronic radiation in nuclear interactions; hard showers; origin of nuclear events.

III. General Discussion of Cosmic-Ray Phenomena: The primary radiation; cosmic-ray phenomena outside the atmosphere; high energy nuclear events; low energy nuclear events; analysis of the hard and soft components; the energy of the meson component; analysis of the electron component; the total energy of cosmic rays at latitudes greater than 45°.

Appendix: The standard atmosphere; momentum and energy loss of heavy particles; angular divergence in the production of secondary particles by nuclear collisions; estimate of the cosmic-ray energy projected upwards in nuclear interactions; estimate of the influence of the angular spread on the total energy of the secondary radiation observed in the vertical direction.

CRYSTALLOGRAPHY

762 The Crystal Structure of Beta-Phase Compounds A_2XF_6 and AXF_4, by W. H. Zachariasen. AECD-2163 (ANL-4104), January 21, 1948, decl. July 20, 1948. 17 p. For oral presentation before a conference on crystallographica held July 28, 1948, at Harvard University and for publication in a technical journal.

It is shown that the following double fluorides: K_2ThF_6, K_2UF_6, $KLaF_4$, $KCeF_4$, Na_2ThF_6, Na_2UF_6, $NaLaF_4$, $NaCeF_4$, and $NaPuF_4$ under proper conditions crystallize with hexagonal symmetry and with closely related structures containing six fluorine atoms and three metal atoms per unit cell.

The compounds K_2ThF_6, K_2UF_6, $KLaF_4$, and $KCeF_4$ have been prepared with the β_1 structure which is based upon the space group $C\bar{6}2m$. The atomic positions for β_1-K_2UF_6 are: 1 U in (0 0 0), 2 K in $\pm(\frac{1}{3}, \frac{2}{3}, \frac{1}{2})$, 3 F in $(\bar{x}_1\ 0\ \frac{1}{2})$ $(0\ \bar{x}_1\ \frac{1}{2})$ $(x_2\ \bar{x}_2\ \frac{1}{2})$ with $x_1 = 0.220$, 3 F in $(x_2\ 0\ 0)$ $(0\ x_2\ 0)$ $(\bar{x}_2\ \bar{x}_2\ 0)$ with $x_2 = 0.640$. The crystals of K_2ThF_6 and K_2UF_6 have been prepared with β_1' structure which is the disordered form of the β_1 structure. In the disordered form the potassium and heavy metal atoms are distributed at random over the sites (0 0 0) and $\pm(\frac{1}{3}, \frac{2}{3}, \frac{1}{2})$.

The sodium compounds and K_2UF_6 when quenched from the melt have the β_2 type of structure which is based upon the space group C32. The atomic positions for β_2-Na_2UF_6 are: 1 U in (0 0 0), 2 Na in $\pm(\frac{1}{3}, \frac{2}{3}, u)$ with $u = 0.385$, 3 F in $(x_1\ 0\ \frac{1}{2})$ $(\bar{x}_1\ \bar{x}_1\ \frac{1}{2})$, with $x_1 = 0.250$, 3 F in $(x_2\ 0\ 0)$ $(0\ x_2\ 0)$ $(\bar{x}_2\ \bar{x}_2\ 0)$ with $x_2 = 0.600$.

In the AXF_4 compounds the sites (0 0 0) are occupied by the heavy atoms, while the alkali atoms and the remaining heavy atoms are distributed at random over the sites $\pm(\frac{1}{3}, \frac{2}{3}, u)$.

The relationship between the β_1- and the β_2-structures is discussed. In the β_1 structure an atom at $(\frac{1}{3}, \frac{2}{3}, \frac{1}{2})$ is bonded to nine fluorine atoms. The corresponding atom is shifted to $(\frac{1}{3}, \frac{2}{3}, 0.385)$ in the β_2 structure and the coordination number is, as a consequence, reduced from nine to six.

763 The Crystal Structure of Alpha-Phase Compounds A_2XF_6 and AXF_4, by W. H. Zachariasen. AECD-2162 (ANL-4105), January 26, 1948, decl. July 19, 1948. 6 p. For oral presentation before a conference on crystallographica held July 28, 1948 at Harvard University and for publication in a technical journal.

It is shown that the compounds K_2ThF_6, K_2UF_6, $KLaF_4$, $KCeF_4$, Na_2ThF_6, and Na_2UF_6 have cubic modifications with the fluorite type of structure. The unit cube thus contains 4 : 8 molecule A_2XF_6 or two molecules AXF_4 with the A and X atoms distributed at random over the metal sites of the fluorite type of structure.

764 A New Interpretation of Interstitial Compounds. Part I. Metallic Carbides, Nitrides, and Oxides of Composition MX, by R. E. Rundle. AECD-2146, n.d., decl. February 24, 1947. 18 p. For publication in Journal of the American Chemical Society.

The metallic monocarbides, nitrides, and oxides generally have the sodium chloride structure irrespective of metal structure or metal radius. These phases are exceedingly hard, brittle, and high melting even though, in many cases, metal-metal bonds have been considerably weakened. These experimental facts require good metal-nonmetal bonds.

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CRYSTALLOGRAPHY

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Since in the first row, light elements appear to form six bonds in the interstitial compound, it is proposed that they are electron deficient bonds of the same type found in the $(CH_3)_3Al$ dimer, the boron hydrides, etc. It is further proposed that the electron deficient bonds consist of "half-bond" pairs in which one element uses one orbital to form two bonds but with the use of a single electron pair. The necessary conditions of elements and bond orbitals used are discussed.

It is shown that these conditions permit the understanding of which metals form interstitial compounds. Moreover, explanations of the co-ordination about the light elements and the physical properties of the phases, including electrical conductivity, result from the proposal.

DEUTERIUM

765 A Comparison of the Ionization Cross Sections of H_2 and D_2, by Richard E. Honig. Journal of Chemical Physics 16, p. 837-838, August 1948.

The sensitivities of H_2^+ and D_2^+ were studied by means of a mass spectrometer at a nominal ionizing energy of 50 electron volts. The following conclusions are drawn: (a) When measured under proper experimental conditions, the H_2^+ and D_2^+ sensitivities are essentially the same. The difference observed, about four per cent, may well be due to instrumental discrimination. While the HD^+ sensitivity cannot be measured experimentally, it is reasonable to assume that it will lie between those of the other two isotopic molecules. (b) Within four per cent, the ionization cross sections (for 50 volt electrons) of H_2^+ and D_2^+ and probably HD^+, are the same. (c) Ion currents are proportional to partial pressure in the reservoir, but not to flow rate, and no mass corrections should be made.

HEALTH PROTECTION

766 Means for Minimising Secondary Radiation in X-Ray Apparatus. British Patent No. 593,352, General Electric Co. and J. T. Caldwell.

Pb (or other metal opaque to X rays) is sprayed on sheets of cellulose acetate (or other material transparent to X rays). The sheets are cut into strips about 0.08 inches wide, edgeburring being carefully avoided. The severed strips are bonded in sets and the edges doped with a solution of cellulose acetate. These units are then bonded into grids of the desired area, the edges doped, and the top and bottom surfaces covered with sheets of cellulose acetate. Parallel, radial, focussed, and crossed grids may be made by suitable modifications.

767 Safety in Laboratories and Plants of Chemical Mineral Products. Part V. Chapter 53. Uranium and Compounds. (La Sécurité dans les Laboratories et les Fabriques de Produits Chimiques Minéraux. Fascicule V. Chapitre 53. Uranium et Composes.) by Francis Barillet. L'Industrie Chimique et le Phosphate Reunis 35, p. 123-128, July 1948. (In French)

A general description of the radiation dangers of radioactive materials and protection against them is given.

INSTRUMENTS

768 High Voltage Pulse-Type Radio-Frequency Power Supply, by R. B. Patten. AECD-2145 (LADC-311), October 10, 1946, decl. November 25, 1947. 10 p. For publication in Review of Scientific Instruments.

A lightweight portable power supply, using sub-miniature tubes, capable of supplying up to 1100 volts at one-half a microampere drain, has been designed. The input is 90 volts at less than 200 microamperes. The weight, excluding the batteries is 140 grams; with the batteries, the total weight is 300 grams. Diagrams and photographs are included.

769 High Energy Neutron Detector, by Clyde Wiegand. AECD-2168 (UCRL-125), April 27, 1948, decl. July 19, 1948. 9 p. For publication in Review of Scientific Instruments. This also includes declassification of the high energy neutron detector.

It is the purpose of the paper to describe a neutron detector suitable for monitoring a flux of neutrons whose energy is greater than about 50 Mev. Detection of the neutrons is accomplished by their ability to induce fission in heavy elements. Kelly and Wiegand (Physical Review 73, p. 1134, 1948) studied the neutron fission of Bi, Pb, Tl, Hg, Au, and Pt at various neutron energies using this counter.

The efficiency of the counter was obtained by determining its counting rate in a measured neutron flux. The result was that the probability of a neutron making a fission in passing through the chamber was about 10^{-6}. A schematic diagram of the high energy neutron detector is given.

770 Beta Ray Spectrometer Magnetic Shielding, by David E. Alburger. Review of Scientific Instruments 19, p. 474, July 1948.

Iron rings spaced along the spectrometer tube provide shielding against the vertical disturbing field. However, these do not appreciably affect the axial horizontal field of the lens coil because of the high reluctance in this direction. 20 rings 1'' wide, 6'' in internal diameter, and 1/4'' thick were made by parting iron pipe. These were spaced 1/2'' apart along the spectrometer tube, leaving a 5-inch unshielded region occupied by the coil. This showed a reduction of 16 per cent. It seems likely that shielding the rest of the center section by rings placed below the coil housing either outside or inside the vacuum chamber would correct for much of the remaining 16 per cent loss.

771 Coincidence-Counting System of High Resolution, by H. L. Schultz and Robert Beringer. Review of Scientific Instruments 19, p. 424-427, July 1948.

A coincidence counting apparatus of high resolution is described. It employs proportional counters whose amplified pulses trigger blocking-oscillators to give artificial pulses which are used in the coincidence discriminator. A continuously variable time delay is provided in one of the amplifier channels for determining the resolving time and for studying delayed coincidences. Under favorable conditions the passage of an ionizing particle through a counter can be determined to within an uncertainty of about 10^{-8} sec.

INSTRUMENTS

772 Dead-Time Reduction in Self-Quenching Counters, by Philip B. Smith. Review of Scientific Instruments 19, p. 453,457, July 1948.

The various methods of dead-time reduction are investigated and discussed. The application of a large negative voltage pulse to the center wire, just after the discharge starts, reduces the dead-time. This effect is due to a combination of stopping the propagation of the ion sheath, ion neutralization, and ion multiplication. In the most favorable case found, the dead-time of a Geiger tube having a normal dead-time of 160 microseconds is reduced to 80 microseconds by this means. Increasing the gain of the detecting circuit without a negative pulse does not reduce the dead-time more than a factor of two, unless the counting rate is greatly increased so that all pulses are small. Operation with high gain just below the Geiger threshold shows efficiency of the order of 50 per cent for beta-particles, and no measurable dead-time.

773 Multiple Geiger Counters for the Observation of Particle Tracks, by William H. Chambers. Review of Scientific Instruments 19, p. 467-470, July 1948.

An array of sixteen, self-quenching, Geiger counters is described, which employs a matrix of parallel, small diameter wires for electrodes. The gas atmosphere is common to all counters. The array and attendant recording circuit is used to observe the tracks of charged particles. A spurious count, caused by incomplete absorption of the photons by the polyatomic gas, occurs in a counter adjacent to the track for about 1.5 per cent of the primary tracks.

774 Noncontact Thickness Gage Uses Radioactive Carbon. Iron Age 162, p. 94, July 29, 1948.

An instrument, developed on the principle that the absorption of beta rays emitted from a radioactive carbon source is a function of material thickness, is being used for noncontact gaging of rubber sheets and other thin films.

775 Particle Detection with Multiplier Tubes, by James S. Allen. Nucleonics 3, p. 34-39, July 1948.

Electron multiplier tubes have been used for fast counting by direct detection of particles and by use of a target screen to emit light for detection purposes. This article describes the design of the tubes, the nature of the screens, and the specific circuits used.

776 A Precision Double-Pulse Generator, by D. J. Medley and H. D. Rathgeber. Journal of Scientific Instruments and of Physics in Industry 25, p. 234-236, July 1948.

A description of an instrument is given for producing either single or repeated pairs of electrical pulses similar to Geiger-counter discharges separated by a time interval which is continuously adjustable from 0 to 75 μ sec.

INSTRUMENTS

777 A Proton-Controlled Magnetic Field Regulator, by Martin E. Packard. Review of Scientific Instruments 19, p. 435-439, July 1948.

A magnetic field discriminator is described which uses the nuclear induction signal from protons to give a ± 75-volt change of direct current voltage for a ± 0.3-gauss change in magnetic field without using direct coupled amplifiers. An ordinary degenerative current regulator with the addition of information from the magnetic field discriminator will control a magnetic field to within 0.02 gauss for a 10 per cent line voltage change or for normal changes in magnet geometry. The magnitude of the magnetic field is maintained in terms of a frequency, the value of which give the absolute magnitude of the magnetic field.

778 Recorder and Timer for Short Intervals, by W. H. Bliss. Electronics 20, No. 11, p. 126-127, November 1947.

The features of an interval timer designed to meet the needs of nuclear research are described. The instrument measures and records intervals up to 16 microseconds with an accuracy of 0.25 microseconds. The intervals to be measured may occur at random and be widely separated.

779 Some Probability Distributions Connected with Recording Apparatus, by C. Domb. Proceedings of the Cambridge Philosophical Society 44, p. 335-341, July 1948.

The probability distribution of recorded events for dead intervals of constant length is expressed by a Laplacian transportation of the distribution with respect to time. The method can be generalized to deal with the case of dead intervals which follow a probability distribution $u(\tau)d\tau$, and for determining asymptotic behavior of distribution of recorded events for large times of observation. It can be applied to alpha-particle counters and similar apparatus.

ISOTOPES

780 Availability of radioisotopes. Chemical and Engineering News 26, p. 2260, August 2, 1948.

A list of investigations utilizing radioisotopes in medicine, biology, and industry is given. The emphasis at present is on the use of radioisotopes in such fields as organic chemistry, catalysis, physical chemistry, metallurgy, mining, and quality control. The basic mechanisms are studied.

The Atomic Energy Commission is sponsoring centers of training to familiarize chemists with safety techniques in handling radioactive substances, at Reed College, Rice Institute, Colorado School of Medicine, and Duke University. Applications for radioisotopes should be made to

Isotopes Branch
United States Atomic Energy Commission
P. O. Box E
Oak Ridge, Tennessee

ISOTOPES

781 Shipping of Radio-Isotopes, by Karl Z. Morgan. Journal of Applied Physics 19, p. 593-598, July 1948.

In this general discussion of the problem the author enumerates the regulation for the shipment of radioisotopes by rail and motor vehicle and the proposed regulations for shipment by air.

MASS SPECTRA

782 Detecting Leaks, by J. E. Burroughs, Chemical Engineering 54, No. 4, p. 112-114, April 1947.

The essential elements and basic procedure of mass spectrometer leak detectors as used in chemical plant equipment are described. Examples of varied application are given.

783 Development of Cold Cathode Ion Source for Mass Spectrometer Type Vacuum Leak Detector, by H. A. Thomas. Texas Agricultural and Mechanical College Engineering Experiment Station Bulletin 101, 1947. 60 p.

The details of a new type of leak detector applicable to high vacuum technology are described. The detector is simple in construction and operation. A discussion of ion sources and ion energies is included. The development of the mass spectrometer tube which utilizes the cold cathode is reviewed.

784 Mass Spectra of Some Organic Compounds, by R. H. Roberts and S. E. J. Johnsen. Analytical Chemistry 20, p. 690-699, August 1948.

Mass spectra on 53 organic compounds and hydrogen are presented. Tables of mass and peak ratios are given.

785 A Mass Spectrometer Magnet, by H. S. Anker. Review of Scientific Instruments 19, p. 440-441, July 1940.

A magnet with ring-shaped pole pieces and a central core makes a large reduction in weight possible, thus eliminating the main obstacle to the use of π-radian mass spectrometers.

786 A Mass Spectrometer of High Resolution, by V. S. Shpinel. Doklady Akademii Nauk SSSR 53, p. 793-796, 1946.

The most accurate modern methods of measuring the impulse of a charged particle are based on its path deviation in a magnetic field. The accuracy of measurement is usually limited by the resolving

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MASS SPECTRA

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power of the instrument, which is determined by its relative aperture and the dimensions of the source. In the most perfect modern instruments, such as a spectrometer with circular focussing or a magnetic lens, the resolution does not exceed several tenths of one per cent.

The present paper suggests a method of increasing the resolution of spectrometers, which is of importance in many investigations (e.g. β-and mass spectroscopy). The advantages of the method proposed are the central position of the source in the instruments, the large distance between the counters and the absence of diaphragms which would considerably lessen the effect of scattered electrons. The resolution of such a spectrometer will be limited by the accuracy attainable in the production of the axially symmetrical field.

787 The Use of Retarding Potentials with the Mass Spectrometer, by R. E. Fox and J. A. Hipple. Review of Scientific Instruments 19, p. 462-466, July 1948.

In addition to the use of stopping potentials for the study of metastable ions in a mass spectrometer, there are several other important uses including the study of ions formed with kinetic energy. There are also several interesting phenomena associated with this method which were encountered when this arrangement was first used. A summary of the authors' experiences with this method is given.

METALLURGY

788 Metallurgy of Malleable Zirconium, by W. H. Knoll, Q. W. Schlechten, W. R. Carmody, L. A. Yerkes, H. P. Holmes, and H. L. Gilbert. Transactions of the Electrochemical Society 92, Preprint 16, p. 187-201, 1947.

A description of developments since 1945 in the production of ductile Zr from zircon sand is given.

MINERALOGY

789 Geiger-Mueller Counters Applied to Mining, by A. W. Knoerr. Engineering and Mining Journal 148, No. 7, p. 92-95, 123, July 1947.

The operating principle and use of Geiger-Mueller radiation counters equipment are summarized. Information supplied by designers, manufacturers and users of the various units is included.

MINERAL RESOURCES

790 Uranium Minerals in Brazil, by Mario da Silva Pinto. Mineracao e Metalurgia 9, p. 177-178, 1945.

A list of occurrences, with analyses is given. Uraninite, samarskite, polycarse, blomstrandite, fergusonite, and eschwegeite have been found.

NEUTRONS

791 Angular Dependence of Coincidences between Fission Neutrons, by S. DeBenedetti, J. E. Francis, Jr., W. M. Preston, and T. W. Bonner. AECD-2153, n.d., decl. July 20, 1948. 18 p. For publication in Physical Review.

An abstract of this document has previously been issued as MDDC-1530 and listed in Abstracts of Declassified Documents.

792 The Resonance Scattering of Slow Neutrons in Crystals, by R. Sternheimer. Physical Review 74, p. 335-340, August 1, 1948.

The theory of the diffraction of neutrons in single crystals is extended to the case in which the neutron energy lies in the region of a nuclear resonance.

793 Transmission of Monoenergetic Slow Neutrons through Solid Solutions and Mechanical Mixtures of TiC and WC, by S. S. Sidhu. Journal of Applied Physics 19, p. 639-641, July 1948. (See also MDDC-1489).

The transmission of neutrons with wave lengths comparable to the interplaner spacings in a crystalline substance have been shown to be modified by the physical state of the substance. In the present investigation the transmission of monoenergetic slow neutrons through finely powdered solid solutions and mechanical mixtures of TiC and WC was measured and the total neutron scattering cross sections determined as a function of the mole per cent of WC. The measured cross sections of both the solutions and the mixtures were found to increase with increasing per cent of WC. For mixtures they are practically the same as the additive cross sections (those computed from measured TiC and WC values according to the proportion in which each compound was present in the particular sample considered); each constituent scatters independently of the other. The cross sections of the solutions are lower than those of the mixtures at low percentages of WC, but increase rapidly with the concentration of the solute molecules. Since the scattering cross sections are in this way sensitive to both the structure of the solvent and the concentration of the substituting atoms, they may be used, for a given structure, as a measure of the solubility of the solute.

NUCLEAR PHYSICS

794 Nuclear Radiation Physics, by Howard L. Andrews and R. E. Lapp. New York, Prentice-Hall, 1948. 408 p.

This book was designed as a college introductory text on nuclear physics.

NUCLEAR PHYSICS – METHODS OF MEASURING

795 The Detection of Beta-Radiation by Photographic Film, by Jock Cobb and A. K. Solomon. Review of Scientific Instruments 19, p. 441-447, July 1948.

The effect of beta-radiation from C^{14} has been examined on nineteen different films. The method employed uses a "radiator," a set of eight radiating sources of different intensities, to replace the stable light source and absorbing wedge common in spectral photometry. With this device sensitivity and contrast of the nineteen films have been measured. Based upon these results and a microscopic estimation of grain size, recommendations are made for the most desirable film for use in radioautography and detection of radioactivity. Of the films examined, Eastman No-Screen X-ray film appears best for the detection of beta rays, and Ansco Reprolith, and Eastman Type M X-ray stripping films appear to be most desirable for work with radioautographs.

796 A Method for Measuring Short Period Activities, by A. D. Schelberg, M. B. Sampson, and Allan C. G. Mitchell. Review of Scientific Instruments 19, p. 458-461, July 1948.

By photographing an oscilloscope it is possible to measure short periods ranging from 0.1 second to 5 seconds. The pulses from a Geiger counter are fed into the x-axis amplifier of an oscilloscope using no sweep. An oscillograph recorder is used to photograph the cathode-ray tube so that a record of all the pulses from the counter is obtained. The activated target is moved from the bombardment position to the counting position in about 0.2 second by means of a pneumatic tube. Exposure of calcium to a 23-Mev alpha-particle beam resulted in an activity with a half-life of 0.58 ± 0.04 second. This activity may be assigned to Ti^{43} produced by the reaction $Ca^{40}(\alpha,n)Ti^{43}$.

797 On the Use of the Kurie Plot, by F. N. D. Kurie. Physical Review 73, p. 1207, May 15, 1948.

The author suggests that the Kurie plot, a method originally suggested for examining experimental data for compliance with either the Fermi or the Konopinski-Uhlenbeck theory of β-decay has been overzealously applied. He states that there is no other method available for examining a β-spectrum for complexity, but that an argument based on Kurie plots alone is not sufficient to establish complexity, and that upper limit values of the lower energy β-particles derived from such an analysis should be viewed with scepticism.

798 Processing Thick Emulsions for Nuclear Research, by C. C. Dilworth, G. P. S. Occhialini, and R. M. Payne. Nature 162, p. 102-103, July 17, 1948.

A brief outline of a method of processing is given which makes possible the production of a nearly uniform development of emulsions 300μ thick, so that the given density in the tracks of particles in regions of equal ionization does not vary by more than 10% from the top to the bottom of the emulsion. The procedure is as follows: the plates are first soaked in water and then in cold developer. The temperature is next raised with the plates protected from a further increase in the concentration of the developing agent. After a suitable period of development further action is checked in a cold stop bath; and the fixing is begun in a cold solution, the temperature of which is afterwards raised.

NUCLEAR PROPERTIES

799 Hyperfine Structure in Line Spectra and Nuclear Spin, 2nd ed., by S. Tolansky. London, Methuen, 1948. 120 p. (See also Abstract No. 156).

During the twelve years that have passed since the writing of the first edition of this volume considerable advances have been made both in the theoretical and experimental aspects of the study of hyperfine structure in line spectra. This has resulted in a good deal of rewriting in the preparing of this edition. Half the chapters are largely new, the other chapters being modified mainly in details. A brief chapter has been added dealing with nuclear electrical quadrupole moment. Isotope effects are treated more comprehensively than formerly.

800 The Magnetic Moment of the Electron, by P. Kusch and H. M. Foley. Physical Review 74, p. 250-263, August 1, 1948.

A comparison of the g_J values of Ga in the $^2P_{3/2}$ and $^2P_{1/2}$ states, In the $^2P_{1/2}$ state, and Na in the $^2S_{1/2}$ state has been made by a measurement of the frequencies of lines in the hfs spectra in a constant magnetic field. The ratios of the g_J values depart from the values obtained on the basis of the assumption that the electron spin gyromagnetic ratio is two and that the orbital electron gyromagnetic ratio is one. Except for small residual effects, the results can be described by the statement that $g_L = 1$ and $g_S = 2(1.00119 \pm 0.00005)$. The possibility that the observed effects may be explained by perturbations is precluded by the consistency of the result as obtained by various comparisons and also on the basis of theoretical considerations.

801 Magnetic Properties of Atomic Nuclei, by Y. T. Frenkel. Izvestiya Akademii Nauk SSSR, Seriya Fizicheskaya 11, p. 593-597, November-December 1947. (In Russian).

The author discusses the determination of the magnetic moments of protons and neutrons, and the non-additive quality of the magnetic moments of complex nuclei.

802 Moments of a System of Two Photons, by L. D. Landar. Doklady Akademii Nauk SSSR, Novaya Seriya 60, No. 2, April 1948. 2 p.

The author discusses the question of the annihilation of slow positrons and electrons as postulated by Pomeranchuk, who stated that in the boundary cases fixed particles, having true two-photon annihilation, return to a zero state if the spin of the electron and positron is parallel. The problem of whether or not this rule can also be applied to electromagnetic waves is discussed.

803 On Closed Shells in Nuclei, by Maria G. Mayer. Physical Review 74, p. 235-239, August 1, 1948. (See also AECD-1818).

Experimental facts are summarized to show that nuclei with 20, 50, 82, or 126 neutrons or protons are particularly stable.

NUCLEAR PROPERTIES

804 Principles of Selection in the Annihilation of Electrons and Positrons, by I. Pomeranchuk. Doklady Akademii Nauk SSSR, Novaya Seriya 60, No. 2 April 1948. 3 p.

The author describes studies conducted to confirm the postulations of Dirac regarding selective principles in the annihilation of electrons and positrons.

805 Tri-Photon Annihilation of Electrons and Positrons, by Ye. M. Lifshits. Doklady Akademii Nauk SSSR, Novaya Seriya 60, No. 2, April 1948. 2 p.

Mathematical formulas for calculating the tri-photon annihilation of electrons and positrons is given.

NUCLEAR THEORY

806 The Conservation of Energy, Momentum and Charge in the Nuclear Field, by H. T. Flint and N. Symonds. Philosophical Magazine 39, p. 413-419, June 1948.

This contribution to the theory of the nuclear field is an amplification of a paper already published on "Energy in the Nuclear Field" (Flint, Philosophical Magazine, Series 7, Paper xxxviii, p. 22, 1947). It contains also the suggestion of a change in the sign of one component of the interaction between a nuclear particle and the nuclear field, but the principles of the theory are the same in both papers. The discussion is limited to the type of field known as the scalar field, but a similar argument may be applied to the other kinds of field occurring in the field theories of the nucleus.

807 Generation of Mesons and Its Dependence on Meson Spin, by S. K. Chakrabarty. Bulletin of the Calcutta Mathematical Society 39, p. 166-176, December 1947.

Approximate expressions for the cross sections of different meson generation processes have been obtained for both transverse as well as pseudoscalar meson. Energy spectrum of nucleons, mesons, as well as integral spectrum of mesons, at different levels of atmosphere were calculated. For the approximate life time of the meson τ is approximately 2.7×10^{-6} sec. The results obtained can be explained by both types of mesons, and it is still not possible to determine whether the sea level mesons are pseudoscalar or transverse.

808 Interaction of Mesons with a Potential Field, by J. C. Gunn. Proceedings of the Royal Society 193 A, p. 559-579, July 21, 1948.

The Takata-Saketani wave equation for mesons is developed to allow the solution of a variety of problems concerning the behaviour of charged vector mesons in an electrostatic field. In particular the form of the radial wave equations is discussed. The general elastic scattering problem is also formulated, and the Born approximation for the phases is discussed for the Coulomb field, for which as is known, no exact solution is possible. The exact treatment of scattering by a spherical well is considered. This is the only case for which exact treatment in terms of known functions seems practicable, and might be of service in indicating the limits of the validity of approximate processes in other cases.

NUCLEAR THEORY

809 A Note on the Calculation of the Spacing of Energy Levels in a Heavy Nucleus, by I. N. Sneddon and B. F. Touschek. Proceedings of the Cambridge Philosophical Society 44, p. 391-403, July 1948.

The authors assume as a model a nucleus consisting of neutrons and protons independent of one another this may be assumed to be a neutron-gas in equilibrium with a proton-gas, Fermi-Dirac statistics being applied to both. The resulting formula for the average spacing of the nuclear levels may be obtained without recourse to thermodynamical arguments.

The method is first applied to the calculation of the density of energy levels in a heavy nucleus and then to the determination of this density when the total angular momentum is given. The method is also applied to the calculation of the spacing of energy levels in the spherical shell model of the nucleus proposed recently by Wilson, (Physical Review 69, p. 538, 1946). Finally, by considering a nuclear model consisting of a spherical core of neutrons surrounded by a spherical shell of protons the discrepancy between the values of the nuclear radius obtained from statistical theory and from many-body theory of α-decay is removed.

810 On the Theory of Elementary Particles, by A. Pais. Amsterdam, North-Holland Publishing Co., 1947. 91 p. (See also Abstract No. 517). STRACT No. 517).

An attempt is made to overcome the difficulty of current theories of elementary particles--their yielding infinite self energies. The method, which is based on quantum mechanics, consists in assuming the elementary particles to be the source of sets of fields such that the various infinite contributions to the self energy to which these fields give rise cancel each other thus making the total outcome finite. Both electrons and nucleons are considered, and it is shown that within given limitations the theory applies.

811 Production of Mesons in the Laboratory, by P. C. Bhattacharya. Science and Culture 13, p. 477-480, June 1948.

A review is made of recent literature on meson production. Comparison is made between laboratory-made mesons and those in the cosmic rays. The laboratory mesons are produced when alpha particles of 380 Mev hit carbon target. Same type scattering and grain density variation are noted as in the case of cosmic ray meson.

The determination of the mass of negative mesons shows a mass of 313-316 m (m = mass of electron), which is the same mass as the mass of the heavy cosmic ray mesons. Furthermore, the life time of the artificially produced mesons is consistent with that of the cosmic ray mesons (about 10^{-9} sec.). There is evidence that positive and negative mesons have different decay periods. The vector mesons are seen to decay into pseudoscalar mesons after a life of approximately 10^{-8} sec. At sea level mesons are all pseudoscalar and disintegrate into electrons and neutrinos. It is not as yet possible to correlate all phenomena regarding mesons detected in cosmic rays with artifically produced ones. 14 references.

NUCLEAR TRANSFORMATIONS

812 Cyclotron Targets: Preparation and Radiochemical Separation. Part III. Na^{22}, by John W. Irvine, Jr., and E. T. Clarke. Journal of Chemical Physics 16, p. 686-690, July 1948.

Two methods for separating Na^{22} from magnesium cyclotron targets are described. The first is a direct precipitation of $NaMg(UO_2)_3(C_2H_3O_2)_9.6H_2O$ or $NaZn(UO_2)_3(C_2H_3O_2)_9.6H_2O$ from an acetic acid solution of the target utilizing the normal sodium contamination of the magnesium for carrier. This is effective for as little as 1 mg of Na in 5 g of Mg. If the sodium contamination is too small for precipitation, the bulk of the magnesium can be removed as $Mg(NH_4)_2(CO_3)_2.4H_2O$ which does not carry sodium.

Deuteron excitation functions for $Mg^{26}(d,\alpha)Na^{24}$ and $Mg^{24}(d,\alpha)Na^{22}$, and thick target yields for the two sodium isotopes are given. The maximum values of the cross sections are: Na^{24}, $\sigma = 0.095 \times 10^{-24}$ cm^2 at 8.5 Mev; and Na^{22}, $\sigma = 0.16 \times 10^{-24}$ at 9.5 Mev. With 14-Mev deuterons the thick target yields are Na^{24} = 8.7 rd/μah and Na^{22} = 65 mrd/μah.

813 The Disintegration of Boron by Slow Neutrons, Part II, by C. W. Gilbert. Proceedings of the Cambridge Philosophical Society 44, p. 447-452, July 1948.

A study has been made of the disintegration of boron by slow neutrons, $B^{10}(n,\alpha)Li^7$, in the cloud chamber. An earlier study, of the same subject by Bower, Bretscher and Gilbert is reported in Proceedings of the Cambridge Philosophical Society 34, p. 290, 1938.

The total ranges of the α-particles and the lithium particles were measured and two groups found. 91.4% of the disintegrations form the main group, which was previously measured, and 8.6% a long-range group corresponding to the lithium left in the ground state. The results of the previous measurements are corrected for the variation of stopping power with velocity and the ranges in standard air of the particles of the two groups are now given as 7.7 mm for the α-particle and 4.8 mm for the lithium particle, total 12.5 mm for the main group, and 9.3 mm for the α-particle and 5.6 mm for the lithium particle, total 14.9 mm for the long-range group.

These results, taken together with those of other workers, make it certain that in about 92% of disintegrations the lithium is left in an excited state of about 0.47 Mev energy and in the remaining 8% in the ground state. The energies calculated from this scheme by using the known masses do not agree with those deduced from the measured ranges and the range-energy relation for α-particles. It is suggested that the range-energy relation is at fault and that these measurements provide two experimental points to which a range-energy relation should be fitted.

The angular distribution of the disintegration particles with respect to the direction of the incident neutron was also measured. No departures from spherical symmetry were detected.

814 The Transmutation of Magnesium, Aluminium and Silicon by Deuterons, by H. R. Allan and Christiane A. Wilkinson. Proceedings of the Royal Society 194 A, p. 131-145, July 28, 1948.

In determining masses of nuclei from Q values, the (d,p) reactions have the greatest accuracy. Magnesium, aluminum, and silicon targets were bombarded by deuterons of 700-1000 Kev in the Cambridge

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one million volt high tension apparatus. The targets were prepared on gold plated copper buttons by depositing the magnesium and aluminum by evaporation in vacuo. The silicon was cut from fused lumps. A proportional counter was used to eliminate the background counting rate. Tentative assignments of responsible isotopes were made from observations of the induced radioactivity. A resonance level in the compound nucleus of Al^{27} at an excitation energy of 17 Mev is indicated.

The following assignments were made:

$Mg^{24}(d,p)Mg^{25}$	Q = 5.03 Mev	
$Mg^{25}(d,p)Mg^{26}$	Q = 4.45 Mev	(to excited state)
$Mg^{26}(d,p)Mg^{27}$	Q = 4.05 Mev	
$Al^{27}(d,p)Al^{28}$	Q = 5.46 Mev	
	= 4.46 Mev	(to excited states)
	= 3.98 Mev	
	= 3.31 Mev	
$Si^{28}(d,p)Si^{29}$	Q = 6.16 Mev	
	= 4.87 Mev	(to excited states)
	= 3.75 Mev	
$Si^{30}(d,p)Si^{31}$	Q = 4.16 Mev	

In the case of Mg three distinct components of half lives, 10 mins. (positrons), 2.1 hrs. (F^{18}), and 14.8 hrs. (Na^{24}) were noted. Silicon target showed presence of activity decaying with half life of 175 mins. ($Si^{30}(d,p)Si^{31}$).

815 Use of an Electron Multiplier Tube as a New Technique in Disintegration Experiments, by Leticia Del Rosario. Physical Review 74, p. 304-314, August 1, 1948.

An electron multiplier tube with 12 electrodes has been used as a detector in the bombardment of beryllium by protons of energy 239, 268, and 397 kv. The disintegration particles from the two possible reactions $Be^9(p,\alpha)Li^6$ and $Be^9(p,d)Be^8$, were selected by an electrostatic analyzer which measured directly their energies. The results for each bombarding voltage are given as an energy distribution curve which shows a complete resolution of the various peaks. All the particles, except the unstable Be^8, were detected, and interesting feature being the detection of the recoil nucleus Li^6 in its three states of ionization. The perfect resolution of the peaks is due to the fact that the target used was extremely thin and that no windows were used in the complete path of the particles for the target, through the analyzer and unto the detector, since the multiplier tube works in vacuum. Thus, no straggling was observed, and the width of the peaks coincide with the values predicted by the theory of the electrostatic analyzer for the slits used in these experiments. The ratios in which the three lithium ions appear are given and the problem of the probability for capture or loss of electrons by the ions is briefly discussed, on the basis of the ratio γ of the electron orbital velocity to the velocity of the ion itself, as suggested by Bohr (Physical Review 58, p. 654, 1940; 59, p. 270, 1941) and used by Knipp, Teller, and Brunings (Physical Review 60, p. 657, 1941) in their treatment of heavy ions. The calculated values for γ are:

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for the process $Li^{+++} \rightleftarrows Li^{++}$, $\gamma = 1.22$ and for $Li^{++} \rightleftarrows Li^{+}$, $\gamma = 1.09$, which have a net effect of favoring the doubly ionized state of lithum. The actual counting rates observed indicate, in fact, that the Li^{++} is the more abundant of the three ions.

NUCLEONICS

816 Nucleonics and Electronics, by K. Henny. Electronics 20, No. 6, p. 80-81, June 1947.

The term nucleonics is defined as a generic name for atomic energy and related subjects. The field of knowledge comprehended by nucleonics is briefly discussed and its relationships to electronics is considered. Electronics is based on the ability to control and put to work electrons which surround the atomic nucleus while nucleonics relates to the control and utilization of other parts of the atom associated with the nucleus. Subdivisions of nucleonics are given.

PARTICLE ACCELERATORS

817 Character of the Radiation Field and Shielding at the 184" Cyclotron, by B. J. Moyer, R. Hildebrand, N. Knable, T. J. Parmley, and H. York. AECD-2149 (BP-76), n.d., decl. July 9, 1947. 9 p. For oral presentation at a meeting of the American Physical Society held at Stanford University on July 11-12, 1947. Document for sale by AEC.

An abstract of this document has been issued as MDDC-956 and listed in Abstracts of Declassified Documents.

818 The Design of Linear Accelerators, by J. C. Slater. Reviews of Modern Physics 20, p. 473-518, July 1948.

The advantages and disadvantages of the linear accelerator, as well as the design difficulties due to defocusing are discussed. The geometrical factors affecting acceleration and efficiency of acceleration are discussed, as is the feeding of power from power amplifiers and self-excited oscillators. The tolerances in the accelerator and the dynamics of the particles, focusing, and transversal motion, as well as the periodically loaded wave guides, are theoretically treated. The special case of the π tube used in the M.I.T. accelerator is discussed. A comparison is also made of the expected performance of the M.I.T., Stanford, and Berkeley accelerators. 37 references.

PARTICLE ACCELERATORS

819 The Electrostatic Generator Used in Nuclear Studies, by W. E. Shoupp. Electrical Engineering 67, p. 668-671, July 1948.

Nuclear reaction threshold studies represent powerful means for the measurement of mass differences in nuclear reactions and lead to very accurate mass values and other basic nuclear information. The chief error of such measurements in the calibration of absolute voltage scale. Radio-frequency techniques are discussed which may assist materially in overcoming this difficulty by offering direct velocity measurements which are independent of nuclear reactions or resistance measurements. The advantages of the Van de Graaff generator in precision nuclear measurements such as threshold reaction studies scattering experiments and cross section determinations in pointed out.

820 Experimental Results on Standing Wave Type Linear Accelerators for Electrons, by Elliott J. Lawton and W. C. Hahn. Journal of Applied Physics 19, p. 642-647, July 1948.

Work done on the development of a resonant cavity type linear accelerator is briefly described. The experimental results demonstrate that electrons entering at low energies will accelerate to a higher energy in passing through a group of cavities of equal $\beta(\lambda_0/2)$ spacing and along which appears a standing wave field distribution. Starting at 57 kv, an energy of 0.345 Mev was attained with two cavities. An 8-cavity accelerator of cavity length corresponding to $\beta = 0.75$ had a maximum output of 0.75 Mev. Experimentally determined energies were in fair agreement with theoretical values at equal axial gradients. Excitation power was found to be proportional to $[(\text{Mev})^2/\text{Length}]\ (1/Q)x$ coupling coefficient. The power required for an axial gradient of 1 Mev/ft., even for the most favorable design, was high and would require the full output of one HK7 type magnetron for each foot of accelerator length. Energy spread in the accelerated beam was large for the two cavity tubes but small for the longer 8-cavity tube. It is believed that the apparent low energy spread observed in the 8-cavity case resulted from a limited range in entering angle brought about by the reduced axial gradient. There was little evidence of radial defocusing. A change in resonance wave-length amounting to + 0.000225 cm per degree centigrade was oberved. There was indication that the magnetron would follow a resonance change of approximately 5°C.

821 High-Energy Particle Accelerators, by J. R. Woodyard. Electrical Engineering 67, p. 759-767, August 1948.

Four basically different kinds of machines for producing high energy charged particles in the energy range from a million electron volts up to perhaps ten billion electron volts are described. These four are the d-c machines, the magnetic resonance accelerators, the magnetic induction accelerators, and the radio-frequency linear accelerators.

The d-c machines, of interest chiefly for the lower voltages, include two types, the cascade rectifier and the electrostatic generator. The magnetic resonance group, which has been the most highly developed to date, includes four machines; the constant-frequency cyclotron, the frequency-modulated cyclotron, the electron synchrotron, and the proton synchrotron. Magnetic induction accelerators include only one example, the betatron. The radio-frequency linear accelerators include two quite different machines; the electron linear accelerator, and the proton linear accelerator. Progress toward higher energies has been rapid and steady. During the past twenty-five years, the voltage attainable have increased rather uniformly by about a factor of ten every six years.

PARTICLE ACCELERATORS

822 Rising Sun Magnetrons with Large Numbers of Cavities, by A. V. Hollenberg, N. Kroll, and S. Millman. Journal of Applied Physics 19, p. 624-635, July 1948.

Studies of the rising sun design for magnetron oscillators have been extended to large numbers of cavity resonators. Successful operation of pulsed magnetrons having as many as 38 cavity resonators has been achieved in the 1.25-cm wave length region. The open cavity resonators heretofore used in rising sun magnetrons were found unsuited for oscillators containing a large number of cavities. The extension to higher numbers was made possible by the use of closed-end resonators. This modification in cavity geometry produces a favorable redistribution of the spectrum of the resonant modes of the rising sun structure, thereby making possible the operation of the magnetron in the desired π-mode without disturbance from other modes. The increase in the number of cavity resonators for magnetrons should serve to facilitate the extension of present magnetron techniques to the millimeter range and to increase the radiofrequency power obtainable from magnetrons at 1 cm and at longer wave lengths.

PHYSICS, GENERAL

823 Multiplicative Systems in Several Variables. Part I, by C. J. Everett and S. Ulam. AECD-2164 (LADC-534), May 6, 1948, decl. July 30, 1948. 34 p. For publication in a technical journal.

This report is the first of a series developing the probability theory of systems of particles of many types, differing in nature, position, and velocity, which undergo transformations of type. The principal technique is that of the generating transformation (G) whose iterates yield the probability distributions for higher generations. The properties of (G) with respect to fixed points which determine criticality, convergence under iteration, and relation to first moment matrix (M) are obtained. Necessary and sufficient conditions for supercriticality of the system in terms of (M) are given. A ratio theorem is proved for supercritical systems stating that, with overwhelming probability, the distribution of progeny among types in high generations will be essentially in the ratios of the unique characteristic vector of the first moment matrix (M) of (G).

824 Multiplicative Systems in Several Variables. Part II, by C. J. Everett and S. Ulam. AECD-2165 (LADC-533), June 11, 1948, decl. July 30, 1948. 22 p. For publication in a technical journal.

In this report is continued the generalization of the methods and results of Hawkins and Ulam (See also MDDC-287) which began in AECD-2164, being concerned principally with systems which are below critical. After deriving necessary and sufficient conditions for this state in terms of first moments, the direction of flow induced in the "unit cube" by the corresponding generating transformation is studied. The latter results are used to show that the distribution of the generation in which death first occurs possesses moments of all orders.

Limits of expectations are obtained for the problem of subcritical system with source, and for that of total progeny (corpses) in subcritical systems. Finally, it is shown how fictitious particles of new types may be introduced in such a way that certain more complicated problems may be reduced to the case of simple iteration of generating transformations. In particular it is shown how this may be accomplished for the system with source, and for the problem of total progeny. The next report of this series will deal with measure theorems on the space of all genealogies possible in multiplicative systems.

PHYSICS, GENERAL

825 The Energies of Electrons in Aluminium, by Z. Matyas. Philosophical Magazine 39, p. 429-449, June 1948.

In the first part of this paper it is shown, by means of the general Bloch method, (Zeitschrift fur Physik 52, p. 555, 1928), how it is possible to construct the probable band structure of aluminium. The distribution of its three valence electrons in the two Brillouin zones is the following: the first zone is nearly full and the Fermi surface lies near the bounding square faces of this zone in the (100) directions. The second zone is partly filled with one electron and the Fermi surface has the shape of semiellipsoids surrounding the eight points ($\pm\pi/a, \pm\pi/a, \pm\pi/a$) of the k-space. The second part of this paper contains the interpretations of some principal features of the soft X-ray emission spectra of aluminium.

826 Ionization Processes on Tungsten Filaments. Part I. The Electron Affinity of the Oxygen Atom, by Max Metlay and George E. Kimball. Journal of Chemical Physics 16, p. 774-778, August 1948.

The electron affinity of the oxygen atom was determined from measurements of the relative electron and ion currents in a pyrex tube containing nitrous oxide and a .02 cm. diameter central tungsten filament. It is shown that measurements using oxygen gas as the carrier do not yield the correct electron affinity of oxygen atom. The average electron affinity of the oxygen atom is $53.8 \pm .8$ kcal per mol (average diviation was 1.3) as determined from 34 runs. A plot of the calculated electron affinity as a function of temperature is included.

827 Ionization Processes on Tungsten Filaments. Part II. The Absorption of Fluorine on Tungsten, by Max Metlay and George E. Kimball. Journal of Chemical Physics 16, p. 779-781, August 1948.

Fluorine forms a very stable atomic layer on the surface of tungsten, which does not desorb below 2600°K, thus causing a low accommodation for the thermal dissociation of fluorine. A less stable layer is believed to adsorb over the first layer. The fraction of fluorine dissociated on the surface of the tungsten is exponential in temperature.

828 Low Temperature Physics, 2nd Ed., ed by L. C. Jackson. London, Methuen, 1948. 130 p.

Chapter headings are: the production of low temperatures; the measurement of low temperatures; liquid and solid helium; specific heats; electrical conductivity; magnetism.

PHYSICS, GENERAL

829 Report of an International Conference on Fundamental Particles and Low Temperatures. Vol. I. Fundamental Particles. 200 p. Vol. II. Low Temperatures. 147 p. London, Physical Society, 1948.

The Conference on Fundamental Particles and Low-Temperature Physics, held at Cambridge in the summer of 1946, was a joint project of the Physical Society and of the Cavendish Laboratory. Vol. I records the five sessions on fundamental particles: General Introduction and Survey; Mesons and Cosmic Rays; Experimental Techniques; Nuclear Forces and Relativistic Particles; and Theory of Heisenberg's S-Matrix. Vol. II records the sessions on low temperatures: Liquid Helium II; Experimental Technique; Superconductivity; Paramagnetics.

830 Some Physical Instruments Used in Medicine, by David S. Evans. Endeavour 6, No. 22, p. 69-75, 1947.

A discussion with diagrams is presented of the problems of measuring blood pressure and the medical use of infra red radiations with appropriately devised instruments of accuracy and endurance. Other applications of physics to medicine, which are considered include electronics, artifically radioactive substances, and high voltage X-rays and neutrons.

831 The Vapor Pressure and Heat of Sublimation of Graphite, by Leo Brewer, Paul W. Gilles, and Francis A. Jenkins. Journal of Chemical Physics 16, p. 797-807, August 1948.

The heat of sublimation and the heats of dissociation of CO and C_2 are determined by an equilibrium effusion method and by the determination of the partial pressure of C_2 (gas) in equilibrium with graphite. A table of $C_2(g)$ pressure above graphite as a function of temperature is given, as is a table of experimental vapor pressure and heat of sublimation of graphite. The data indicate a relatively high accommodation coefficient, and it is seen that the carbon evaporates from the solid as monatomic gas in the ground electronic state. The heat of sublimation of graphite to C(g) and $C_2(g)$ is $\Delta H_0 = 170.39 \pm .20$ kilocalories and $\Delta H_0 = 233.1 \pm 7$ kilocalories per mole at 0°K, respectively. The heats of dissociation of C_2 and CO are $4.7 \pm .3$ and $11.109 \pm .01$ electron volts, respectively. The accommodation coefficient of carbon gas on graphite at high temperatures is about .3, and vaporized carbon gas is shown to be in the ^3P ground state.

QUANTUM MECHANICS

832 Non-Product Wave Function for a Negative Ion, by Esther Conwell. Physical Review 74, p. 268-278, August 1, 1948.

A departure from the Hartree type wave function was attempted along lines found successful for H^-. The basic ψ taken was a product of the nine Hartree one-electron functions for O^- multiplies by a term including r_{ij} terms representing what were considered the most important electron interactions—those between four of the 2p electrons and a fifth, arbitrarily considered the added one. Since there

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QUANTUM MECHANICS

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are six possible configurations for five equivalent 2p electrons, the actual ψ was taken as a linear combination of the six possible ψ's of the type described. Minimizing the energy with respect to the coefficients in this linear combination leads to the same type of secular equation as is obtained in perturbation theory. It is shown that only the diagonal elements of the determinant are non-vanishing, and one of these is chosen for the evaluation of the energy. The electron affinity to be obtained using this wave function is considerably greater than the value gotten by Hartree, Hartree, and Swirles, perhaps twice as much.

833 Wave Functions for H^- Obtained by Variation Method, by Esther Conwell. Physical Review 74, p. 277-278, August 1, 1948.

A wave function for H^- of the form $\psi = f_1(r_1)f_2(r_2)(1 + cr_{12})$ was set up. For a given value of the parameter c, determination of the functions f_1 and f_2 which will make the energy a minimum leads to a pair of simultaneous integro-differential equations for f_1 and f_2 with the energy as a parameter. Numerical integration of these for different values of the energy and c was carried out for the cases: (1) f_1 identical with f_2, and (2) f_1 taken as the function e^{-r}, the ground state of a neutral hydrogen. Neither of these gave as good a value of the electron affinity as has been obtained with previously investigated analytic functions.

RADIOACTIVITY

834 The Isolation of Element 43 and Some Observations on Its Chemical Behavior, by G. E. Boyd, Q. V. Larson, and E. E. Motta. AECD-2151, June 14, 1948, decl. July 19, 1948. 16 p. For oral presentation before an American Chemical Society Symposium on New Elements, Syracuse, N. Y., June 30, 1948.

An abstract of this document has previously been issued as MDDC-1696 and listed in Abstracts of Declassified Documents.

835 Artificial Collateral Chains to the Thorium and Actinium Families, by A. Ghiorso, W. W. Meinke, and G. T. Seaborg. AECD-2166 (UCRL-134), June 18, 1948, decl. July 29, 1948. 8 p. For publication as a Letter to the Editor in Physical Review.

Two new series of alpha particle emitting radioactive elements have been produced and identified; one is a collateral branch of the actinium (4n + 3) radioactive family and the other is collateral to the thorium (4n) family. The series are of considerable interest in that they are the first whose early members lie on the neutron deficient side of beta stability. They have been produced in high yield by irradiation of thorium with deuterons of energy about 80 Mev in the Berkeley 184-inch cyclotron. Present observations indicate that both of these series begin with isotopes of protactinium (atomic number 91), although progenitors with higher atomic numbers are to be expected and will possibly be produced and identified. These protactinium isotopes are Pa^{227} and Pa^{228} formed by (d, 7n) and (d, 6n) reactions, respectively. Decay schemes are proposed for both series.

RADIOACTIVITY

836 Disintegration of $_9F^{18}$, by Zah-Wei Ho. Comptes Rendus 226, p. 1187-1189, 1948. (In French)

Cloud-chamber studies were conducted of the decomposition of F^{18}. A complex β^+ spectrum was shown with two components of maximum energy 950 and 600 Kev. There were also recoil electrons with a maximum energy of 1.2 Kev.

837 The Disintegration of Scandium^{46}, Gold^{198}, and Tungsten$^{185, 187}$, by Charles L. Peacock and Roger G. Wilkinson. Physical Review 74, p. 297-303, August 1, 1948.

A survey of the nature and energies of the radiations of some radioactive isotopes of Sc, Au, and W has been made with a small 180° spectrometer of fair resolution. Samples were produced by neutron and deuteron activation.

The 85 day isotope of Sc is found to decay by the emission of two groups of beta-rays of maximum energies 0.36 and 1.49 Mev. The low energy group constitutes 98 per cent of the total number of electrons. The residual Ti^{46} nucleus returns to the ground state by the cascade emission of two gamma-rays are converted with K conversion coefficients of 0.0008 and 0.0004 respectively.

The decay scheme of Au^{198} is found to be simple. The emission of a beta ray of a single group, E_{max} = 0.97 Mev, leads to an excited state of Hg^{198} which returns to the ground state by the emission of a 0.408 Mev gamma ray. The gamma ray is converted with $\alpha_K = 0.25$.

The radiations of 24-hour W^{187} are complex. Two groups of beta rays are present which have end points at 0.63 and 1.33 Mev. Five gamma rays are noted with energies of 0.14, 0.21, 0.48, 0.62, and 0.69 Mev. The decay of the 77-day isotope, W^{185}, seems simple. A single beta ray is found with an end point at 0.43 Mev.

838 Gamma-Ray Spectrometer Measurements of Fluorine and Lithium under Proton Bombardment, by R. L. Walker and B. D. McDaniel. Physical Review 74, p. 315-327, August 1, 1948.

The spectra of the gamma radiation emitted by lithium and fluorine under proton bombardment have been investigated with a spectrometer which measures the total energy of electron pairs produced in a thin radiator exposed to the gamma radiation. A long suspected 14.8 Mev gamma-ray line from the 44 Kev resonance in lithium has been clearly resolved from the well known sharp line at 17.6 Mev. The gamma radiation from fluorine has been found to consist of two lines at 6.13 ± 0.06 and 6.98 ± 0.07 Mev, rather than a single line as previously believed. Possible variations in the positions and in the relative intensities of the two lines of each spectrum with changes in the proton energy have been investigated by using protons of energies approximately 0.45, 0.7, and 1.15 Mev from the Cornell cyclotron. The gamma-ray spectrometer used in these measurements is described, and a discussion given of the factors limiting its resolution. The resolution is such that the observed width at half maximum of a sharp gamma-ray line is approximately 5.5 per cent of its energy.

RADIOACTIVITY

839 The Half-Life of Thorium C′, by J. M. Hill. Proceedings of the Cambridge Philosophical Society 44, p. 440-446, July 1948.

The half-life of ThC′ (Po^{212}) was determined by a new method of coincidence technique. Previous investigators have recognized difficulties in regard to this investigation. These were: (a) random delays in the counters; (b) coincidences due to other disintegrations; (c) possibility of difference in delays in recording α- and β-particles. In this investigation the difficulties arising from these effects have been overcome.

From this type of experiment it is possible to determine the order in which the particles are emitted. It would appear that the time of breakdown of a counter depends, to some extent upon the magnitude of the initial ionization. The value for the half-life of ThC′ was found to be $3.0 \pm 0.15 \times 10^{-7}$ sec.

840 The Isotopes Os^{185} and Os^{193}, by Leonard I. Katzin and M. Poberskin. Physical Review 74, p. 264-267, August 1, 1948. (See also AECD-1837).

The half-life of Os^{193} is shown to be 15.0 days, decay being by emission of a beta-particle with range less than 35 milligrams per square centimeter of aluminum (energy not more than 0.165 Mev). A highly converted gamma-ray of about 0.13 Mev energy is probably emitted at each disintegration, producing X rays in large abundance. Os^{185} decays by orbit capture with a half-life of 97 days. A gamma-ray of 0.75 Mev is probably emitted at each event. The relative cross sections for pile (slow) neutron capture of the isotopes Os^{184}, Os^{190}, and Os^{192} have been estimated at 80:3.5:1, on the basis of measurements on the daughter activities.

841 The Radioactive Decay Constants of K^{40} as Determined from the Accumulation of Ca^{40} in Ancient Minerals, by L. H. Aherns and Robley D. Evans. Physical Review 74, p. 279-286, August 1, 1948.

New measurements of the rate of emission of gamma-ray energy by K^{40} give 4.9 ± 0.1 Mev/sec. g K, in agreement with Gleditsch and Graf. Thus the minimum value of the probability of electron capture in K^{40} is $\lambda_e = 0.062 \times 10^{-9}$ yr.$^{-1}$. Spectrochemical analysis of 4 samples of lepidolite known to be 2.1×10^9 years old, as well as 22 younger lepidolites, gives a maximum value of 22, and a most probable value of 11 for the ratio of radiogenic Ca^{40} to residual K^{40} in the 2.1×10^9 year old minerals. In such an ancient mineral, the Ca^{40}/K^{40} ratio is a function not only of the probability of β-ray decay, λ_β, of K^{40} into Ca^{40}, but also the probability of transformation by electron capture, λ_e, of K^{40} into A^{40}. This is because the electron capture process may significantly deplete the K^{40}, thus tending to produce larger Ca^{40}/K^{40} ratios than would result from β-decay alone. Approximate correction are suggested for the effects of β-ray scattering in observations by Mühlhoff (Annalen der Physik 7, p. 205, 1930) and by Bleuler and Gabriel (Helvetica Physica Acta 20, p. 67, 1947) on the absolute rate of emission of β-rays by K. These corrections lead to a mean value value of 34 β-rays/sec. g K, or $\lambda_\beta = (0.65 \pm 0.1) \times 10^{-9}$ yr^{-1}. The observed value of $C^{40}/K^{40} = 11$ then leads to $\lambda_e = (0.9 \pm 0.1) \times 10^{-9}$ yr^{-1}, and a total half period of $T = (0.45 \pm 0.05) \times 10^9$ yr for K^{40}. Then approximately 42 per cent of the disintegrations of K^{40} are by β-ray emission to the ground state of Ca^{40}; 4 per cent by electron capture to a 1.5 Mev excited state in A^{40}, and 54 per cent by electron capture to the ground state of A^{40}. It is shown that these revised disintegration constants lead to a sufficiently smaller thermal output by K early in the earth's history to satisfy Birch's (Physical Review 72, p. 1128, 1947) calculations on the possibility of an early solid terrestial crust, and to remove arguments relating to the origin of species through gene mutations caused by intense K^{40} radiations early in the earth's history.

RADIOCHEMISTRY

842 Model Experiments on the Primary Biological Effect of Radiation, by A. Mullis, W. Minder, A. Liechti, and F. Wegmüller. Radiologia Clinica 15, p. 295-312, 1946.

Solution of p-dichlorobenzene in ether of various concentrations were prepared, dissolved in conductivity water, and irradiated with X-rays to examine the effect of concentration on the radiation hydrolysis of halobenzenes. No certain radiation hydrolysis could be found. Saturated aqueous solutions of p-dichlorobenzene when irradiated with X-rays furnish HCl in an amount approximately proportional to the doses of radiation. Dissociation of p-dichlorobenzene occurs only in the presence of water; this reaction undoubtedly is a radiation hydrolysis. Hexachlorobenzene in saturated aqueous solution does not undergo radiation hydrolysis. This indicates that in the radiation hydrolysis of polychlorobenzenes both hydrogen and chlorine atoms are probably directly involved.

843 A Theoretical Study of the Results of Ionization Measurements in Water with X-Ray and Gamma-Ray Beams. Part II, Discussion on Results of Calculations and Comparison with Experiment, by L. F. Lamerton. British Journal of Radiology 21, p. 352-364, July 1948.

An attempt is made to provide a theoretical basis for the results of depth dose measurements in water with X rays and γ-rays. The work of previous investigators and the lumitations of their methods are discussed. A method of calculation based on the Klein-Nishina scattering formula which allows an approximation to the effect of multiple scatter is described. Conversion from intensity values into dose values is investigated, and also the effect on the depth dose of the heterogeneity of the primary radiation. Methods of correcting the calculated values for finite focal distance are put forward. It is shown that over a wide range of wave lengths the geometrical distribution of scattered radiation predicted by the Klein-Nishina formula can be expressed in a much simplified form with sufficient accuracy for these caluclations.

Calculated values of depth dose and intensity for wave lengths between 120 X.U. and 4.8 X.U. are compared with the values given in the survey of experimental data by Mayneord and Lamerton. In general, the calculated values for soft radiations are too low, but there is good agreement for radiations of H.V.L. in the region of 10 mm Cu. For harder radiations, where multiple scattering plays only a small part, it is possible that the calculated values are more reliable than the survey values which are based on only a small amount of experimental data. Calculations are given of the percentage depth dose to be expected from the γ-radiation of radiocobalt used at 25 cm focal distance. Finally, the effect of an air-space round the point of measurement is investigated theoretically and the general problem of scattering in a non-homogeneous medium is discussed.

RADIOTHERAPY

844 Biological and Medical Use of Artificial Radio-Elements, by L. Mallet. Atomes et Radiations 1, p. 127-135, 1948.

RADIOTHERAPY

845 The Medical Use of Radioactive Isotopes. Part II, Radio-Iodine and the Thyroid, by F. R. Keating,Jr. American Journal of the Medical Sciences 213, p. 628-631, 1947.

A combination of two radioactive isotopes of iodine, I^{131} (half-life, eight days) and I^{130} (half-life 12.6 hours) has been used for investigation and for therapy of the thyroid gland and its diseases. Iodine deficiency, administration of potassium thiocyanate and soya bean diet all increases the affinity of the thyroid for iodine, while previous administration of iodine or of thyroxin and hypophysectomy reduce it. Thiouracil and related goitrogenic substances markedly decreased iodine collection before any other effects of these agents were evident. The microscopic distribution of the radioiodine in the thyroid may be investigated by the technique of autoradiography. The deposition and disappearance of iodine has been studied by placing a Geiger-Muller counter over the gland.

The results in the treatment of hyperthyroidism are encouraging since remissions were observed in a majority of cases. Of 22 patients treated by Chapman and Evans, 20 were relieved of hyperthyroidism; in 4 of the 20 cases myxoedema developed. Mild reactions resembling radiation sickness occurred in six cases. It is difficult to determine the dose of radiation received, this depending upon the weight of the thyroid, its rate of iodine turnover and energies of the isotopes employed.

846 Neutrons Disappointing in Cancer Treatment. Science News Letter 54, p. 70, July 31, 1948.

Neutrons have turned out to be less effective in the treatment of cancer than was once hoped.

847 Preliminary Report on the Chemical Use of Radioactive Iodine (I^{131}), by Earl R. Miller, Mayo H. Soley and Morris E. Dailey. American Journal of Roentgenology and Radium Therapy 60, p. 45-50, July 1948.

This study was made to determine if possible the uptake of radioiodine in microcuries in the human thyroid in situ after oral administration of I^{131}. Patients with Graves' disease and thyroiditis were given iodine solution calibrated in microcuries per centimeter in 50 cc of water. Measurements were made during the following two days and then at one - or two-week intervals to the end of a month when the patients were clinically re-evaluated. A Geiger counter, witn a lead shield to permit recording of harder radiation only, was used vertically 29 to 53 cm from the patient's thyroid for determining the number of microcuries in the thyroid. Readings were also taken over the thigh just above the knee. They were subtracted from the readings taken over the neck and thyroid to give the readings of the iodine in the thyroid only. Doses of I^{131} varied from 800 microcuries in a single dose to 250 microcuries per week for six weeks. Composite curves of the results on metabolic rate and the protein-bound iodine show a fall at first, but this is soon followed by a return to normal. The amounts of iodine used were too small to be effective.

RADIOTHERAPY

848 Radioactivity Aids Ills. Science News Letter 54, p. 85, August 7, 1948.

The Atomic Energy Commission in its fourth semi-annual report to Congress told of many phases of its work which are being carried on at medical schools and hospitals throughout the country. These include the study of radioactive phosphorus in the treatment of patients suffering from polycythemia vera; an attack on the cancer problem with radioactive calcium; a study of nerve disorders and thyroid gland function with radioiodine and radioactive phosphorus; an investigation of the resistance of animals to specific germ diseases through the use of radioactive carbon, phosphorus and arsenic in preparing radioactive antigens; speedy determination of blood loss and blood needs of patients undergoing surgical operations; and a study of what vitamins do in the body. All of these projects employ radioactive elements in their procedures.

849 Spontaneous and Experimentally Induced Uptake of Radioactive Iodine in Metastases from Thyroid Carcinoma; a Preliminary Report, by S. M. Seidlin and A. A. Yalow. Journal of Clinical Endocrinology 8, p. 423-432, June 1948.

Fourteen patients with unselected cases of metastatic carcinoma of the thyroid and on nonrestricted diets were given orally doses of I^{131} ranging from 500 to 2000 microcuries. A Geiger-Mueller counter was used for in vivo reading and radioautography for biopsy material. Uptake of the iodine was demonstrated in 8 (57 per cent) of the cases and was more closely related to the degree of preceding surgical or radiation thyroidectomy than to the histologic structure of the tissue. Concentration of radioiodine in metastatic carcinoma of the thyroid for treatment may be induced by injections of thyrotropic hormone or surgical, chemical or radiation thyroidectomy.

850 The Treatment of Cancerous Nodules by External Application of Radio-Phosphorus, by L. Mallet, R. Maurin, and M. Lagourgue. Journal de Radiologie et d'Electrologie 28, p. 424-425, 1947.

RARE EARTHS

851 The Quantitative Spectrographic Analysis of the Rare Earth Elements. Part III. Determination of Major Constituents in Complex Mixtures, by Velmer A. Fassel. AECD-2154, n.d., decl. July 22, 1948. 22 p. For publication in Journal of the Optical Society of America. (See also MDDC-1777.)

Spectrographic methods applicable to the determination of major rare earth constituents in complex mixtures are described. The specific examples discussed are the determination of yttrium and gadolinium in the concentration range of 10 to 100 per cent. The procedures involve the high current d-c arc excitation of mixtures of rare earth oxides, ceric oxide and graphite. Selected lines of cerium are used as internal standards. The choice of cerium as internal standard was based on the relative ease with which any cerium, if present in a mixture, could be preferentially separated from the mixture and then reintroduced in a standard amount. Precision studies show a standard deviation of about $\pm$ 2.5 per cent of the amount present. Data are included which indicate that the high precision is attributable to excellent internal standard control of excitation variables.

RARE EARTHS

852 The Separation of Milligram Quantities of Element 61 from Fission, by G. W. Parker and P. M. Lantz. AECD-2160 (ORNL-75), June 18, 1948, decl. July 19, 1948. 45 p. For oral presentation before a meeting of the American Chemical Society and for publication in a technical journal.

Notwithstanding the numerous advantages of the application of the method of ammonium citrate differential-elution from organic cation-exchange resin columns to rare earth separations, when applied directly to the fractionation of the gross uranium fission-product mixtures, a great variety of cross contamination is encountered. During the initial fractionation process a particular rare earth may coincide almost exactly with elements of three or more groups: an alkali metal, a Group II trivalent element, a Group III trivalent non-fission contaminant, and a transuranic element. In addition, in a large scale remote-control operation, one cannot rely upon an efficient first-fraction collection of a rare earth without inclusion of most of the four nearest earths.

Methods have been developed which tediously eliminate each of the coinciding contaminants from the rare earth elements while work was directed principally toward the purification of milligram amounts of the approximately 4-year element 61^{147}. Methods of detection and illustration of extremely low limits of impurities of adjacent rare earths in the 61 element are indicated by such characterizations as: spark and arc emission spectra, absorption spectra, mass analysis, and X-ray spectra. Neutron radioactivation in the Clinton pile is illustrated as a method of analysis which led to the identification of the 5.3-day 61^{148}. Color observations on element 61 indicate a pink form like neodymium as the nitrate and a canary yellow form like samarium as the chloride.

Incidental purification of the little known long-lived fission isotopes of Sm^{151} and Eu^{155} has permitted a more recent observation of their radiation characteristics.

853 Detection of Scandium, Rare Earths, Zirconium, and Thorium with Murexide, by G. Beck. Analytica Chimica Acta 1, p. 69-71, 1947.

The purple color of murexide (ammonium purpurate) is changed to yellowish-orange by rare earths and scandium when they are added as sulphate solutions, and by zirconium and thorium when added as chloride or nitrate solution. The lowest concentrations of these elements that can be detected by this test are: cerium earths, 20 μg. per ml; thorium, 30 μg. per ml; and zirconium, 75 μg. per ml. Of the purpurates formed, only scandium purpurate is decomposed by the addition of α, α', α'' trimethylamine-tricarboxylic acid (nitrilotriacetic acid), the purple murexide being reformed. The yellow zirconium and thorium purpurate solutions become violet on adding sodium iodate, and scandium purpurate solutions become red on adding sodium acetate in the presence of sodium iodate. An advantage of the murexide test is that aluminium does not interfere. The group of ions considered in this paper can easily be separated from the other ions, zinc, cadmium, ferrous iron, nickel, cobalt, manganous, and uranyl, that give orange colors with murexide. The possibility of using the murexide react on for a volumetric determination of scandium has been examined; the end-point is not sharp.

RARE EARTHS

854 Neutron Induced Radioactivity in Certain Rare-Earth Elements, by J. M. Cork, R. G. Shreffler, and C. M. Fowler. Physical Review 74, p. 240-243, August 1, 1948.

By activating specimens of lanthanum, neodymium, samarium, europium, gadolinium, and terbium in the Oak Ridge pile for a particularly long exposure, several hitherto unobserved radioactivities were found. Determinations are made of the half-lives and of the beta and gamma energies by absorption and spectrometric methods. Lanthanum and neodymium were the only elements showing no internal conversion lines. Terbium appears as a contaminant in its neighboring elements by virtue of its very large cross section for neutron capture. Terbium and europium show complex beta spectra, and each has many conversion electron lines.

855 The Superconductivity of Lanthanum and Cerium, by W. T. Ziegler. Journal of Chemical Physics 16, p. 838, August 1948.

Measurements have been made of the variation of magnetic permeability with temperature down to 2°K. Lanthanum, containing .8 per cent iron had a magnetic transition into superconductivity at $4.85 \pm .15$°K, while lanthanum containing between .5 and 1 per cent aluminum, silicon, and tungsten showed a transition at $4.45 \pm .10$°K. Transition occurred over a range of less than .1°. Cerium showed no sign of superconductivity.

SCIENTIFIC RESEARCH

856 Institute of Nuclear Physics. Science and Culture 13, p. 491-493, June 1948.

An institute of nuclear physics of the University of Calcutta is being built at Calcutta. It will have an area of 25,000 $ft.^2$ and be dedicated to fundamental researches in nuclear physics, nuclear chemistry, and biophysics. A cyclotron could not be completed due to temporary lack of pumping equipment. The University of Peiping is also building a new nuclear physics laboratory.

857 The Medical Program of the Atomic Energy Commission, by Shields Warren. Bulletin of the Atomic Scientists 4, p. 233-234, August 1948.

The medical program of the Atomic Energy Commission may be divided into four parts. First, the maintenance of health of the workers of the Commission and its contractors. Second, the protection of environmental health; this involves such problems as waste disposal, possible contamination of surrounding areas and the like. Third, the development of basic research in those problems peculiarly related to atomic energy, of which the effect of ionizing radiation on the plant, animal and human cell, both isolated and aggregated into organisms, must be determined. Such problems as permissible dose levels of ionizing radiation, metabolism of new or rare elements, the mechanism of radiation injury, the development of therapy for such injury, the character and mode of development of hereditary changes due to ionizing radiation are among those of basic importance. Fourth, the exploration of what, if any, values the new sources of energy available at the installations of the Atomic Energy Commission themselves and the value that very shortlived radioactive isotopes may have in cancer research and cancer therapy.

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SCIENTIFIC RESEARCH

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The aims of the training program administered by the National Research Council for the AEC are summarized.

SPECTROSCOPY

858 Dissociation Energies and Spectra of Diatomic Molecules, by Alfred G. Gaydon. London, Chapman and Hall, 1947. 239 p.

Spectroscopic methods of determining dissociation energies are emphasized; chapters on thermal and controlled electron-impact methods are included. Numerical data for about 250 diatomic molecules are listed. In the appendixes are given some low-level atomic energy terms and also values of the atomic heats of formation of some polyatomic molecules. An extensive list of references is included.

859 New Classifications in Re I and Structure of the Spectrum, by P. F. A. Klinkenberg. Physica 14, p. 269-284, June 1948.

A number of 453 Re I-lines have been classified. The low even levels are dealt with in detail and terms belonging to the configurations $5d^5 6s^2$, $5d^6 6s$ and $5d^7$ are identified. The 6s-electron is more tightly bound than the 5d-electron. Other identifications are given tentatively. The total number of Re I-lines now classified is 1624, accounted for by 1644 transitions between 221 spectral levels. In the region above 2400 A the classified lines represent nearly 65% of all known Re I-lines.

860 New Crystals for Infrared Spectrometry. National Bureau of Standards Technical News Bulletin 32, p. 96-97, August 1948.

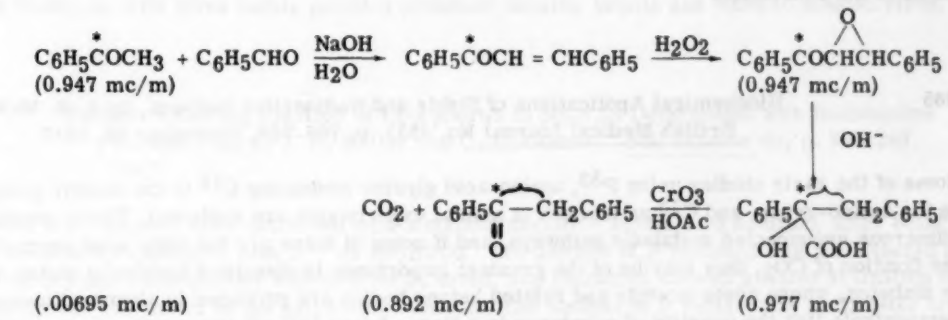
A crystal of thallium halides, large enough to make an infrared spectrometer prism, was grown. The crystal consists of 58 per cent thallium iodide and 42 per cent thallium bromide, is 1-3/4 in. by 2-1/2 in. and was cut to a refracting angle of 26°. Refractive indices were measured from the yellow mercury line to 39.2 microns. In the visible region the value is approximately 2.6, while at 39.2 microns it is about 2.2. This new crystal allows observations to be made out to 40 microns with a prism spectrometer (as compared to 24 microns for potassium bromide). The disadvantages of the crystal are its softness and semiplasticity, which set up internal strains, and the temperature sensitivity of the refractive index. A typical calibration curve of the prism, using the water vapor molecule, is given. It was also determined that the layers of polystyrene and polyethylene can be used as windows in cells up to 40 microns.

TRACER APPLICATIONS, RADIOACTIVE

861 C^{14} Tracer Studies in the Rearrangements of Unsymmetrical α-Diketones. Part II. The Alkaline Rearrangement of Benzalacetophenone Epoxide, by Clair J. Collins and O. Kenton Neville. AECD-2152, n.d., decl. July 20, 1948. 6 p. For oral presentation before a meeting of the American Chemical Society, St. Louis, Missouri, September 1948 and for possible publication in a technical journal. Document for sale by AEC.

The mechanism of the rearrangement of benzalacetophenone epoxide in alkaline solution to give benzyl phenyl glycolic acid has been assumed (Widman, Berichte der Deutschen Chemischen Gesellschaft 49, p. 477, 1916; Jorlander, Berichte der Deutschen Chemischen Gesellschaft 50, p. 406, 1917) to involve the intermediate formation of benzyl phenyl diketone, which then undergoes a benzilic acid rearrangement. The identity of the migrating group may be established by labelling the carbonyl group of benzalacetophenone epoxide with isotopic carbon, since the different modes of reaction will lead to isotopically distinguishable products.

Benzyl phenyl glycolic acid containing no C^{14} in the carboxyl group was obtained from C^{14}-carbonyl-labelled benzalacetophenone epoxide, thus demonstrating that the reaction proceeds by the shift of a benzyl rather than of a phenyl group. The syntheses and degradations were carried out as shown in the scheme below. The radioactive assays, expressed in terms of millicuries per mole (mc/m), were based on ionization chamber measurements of the carbon dioxide formed by wet oxidation of milligram samples.



862 Absorption Measurements on Flour Using Radioactive Isotopes, by J. W. T. Spinks and C. I. Tollefson. Cereal Chemistry 25, p. 139-145, 1948.

A radioactive tracer method is described for determining the adsorption of Ru^{+++} ions by flour by shaking the flour with the solution of Ru^{+++} ions, centrifuging, and counting the aliquots by a Geiger-Müller counter. The difference between the activities of the original and final solutions gives a basis for the calculation of adsorption.

TRACER APPLICATIONS, RADIOACTIVE

863 The Application of Labeled Substrates in the Study of Enzymic Processes, by L. Ahlstrom, H. von Euler, and G. Hevsey. Arkiv for Kemi, Mineralogi öch Geologi 24A, No. 27, 1947. 9 p. (In English)

A study was made of the effectiveness of phosphatases from rat plasma, Jensen sarcoma, and gut mucosa by using as substrate purified desoxyribonucleic acid labeled with P^{32} in vivo. Inorganic and organic trichloroacetic acid soluble phosphate were found after action of the phosphatases. The plasma phosphatase activity from sarcomatous rats was not greater than that for normal rats, and the use of fresh gut mucosa preparations gave greater amounts of organic acid-soluble phosphorus than the aged extractions did. The desoxyribonucleic acids from sarcoma and from the more stable liver seem to be identical as to distribution of labeled phosphorus in the molecule.

864 Atomic Disintegration and Its Biological Applications, by J. Govaerts. Revue Medicale 2, p. 553-560, 1947.

A brief survey of atomic physics and induced radioactivity, and its application to biological and medical problems is presented. Special mention is made of biological results obtained with phosphorus, zinc and iodine as tracer substances and of the technique of autoradiography. Therapeutic possibilities are outlined in the conclusion.

865 Biochemical Applications of Stable and Radioactive Isotopes, by A. S. McFarlane. British Medical Journal No. 4532, p. 766-768, November 15, 1947.

Some of the early studies using P^{32}, amino-acid glycine containing C^{13} in the methyl group and N^{15} in the amino-group, and C^{13} as tracers in animal experiments are reviewed. These studies reveal numerous unsuspected metabolic pathways, and if some of these are but little used normally such as the fixation of CO_2, they may be of the greatest importance in disturbed metabolic states; for example in diabetes, where aceto-acetate and related ketone bodies are produced in abnormal amounts. They demonstrate that the quantity of substance in a tissue bears little if any relation to its metabolic importance, and that important intermediary metabolites may not even be present in detectable concentrations. This heralds a new dynamic point of view in which the body is conceived as in a state of incessant change with atoms and molecules displacing one another with surprising rapidity in every tissue. All that remains constant is the pattern into and out of which these atoms pass, a stereochemical relationship of atoms within molecules, and a spatial juxtaposition of molecules within tissues, which is specific for each individual and characteristic of living matter as a whole.

866 Chemical Studies on Vesicant-treated Proteins, by Frederick H. Carpenter, John L. Wood, Carl M. Stevens, and Vincent Du Vigneaud. Journal of the American Chemical Society 70, p. 2551-2553, July 1948.

A study was made of the cleavage by alkali of the linkages between protein and vesicant residues in preparations obtained by the treatment of insulin, pepsin and tobacco mosaic virus with benzyl β-chloroethyl sulfide (benzyl-H) or n-butyl β-chloroethyl sulfide (butyl-H) containing radiosulfur. The

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extent of liberation of vesicant residues varied with the different proteins; in all cases, a certain fraction of the vesicant residues was not cleaved by the alkali under the conditions studied.

A more detailed investigation of the action of alkali on vesicant-treated insulin showed that the rate of liberation of vesicant residues was dependent upon the temperature and pH of treatment. Heating of vesicant-treated insulin at 150° in neutral solution also resulted in the liberation of vesicant residues.

By application of the "washing-out" technique to the radiosulfur-containing material cleaved from butyl-H- or benzyl-H-treated insulin, the cleavage product was demonstrated to consist mainly of the corresponding alkyl β-hydroxyethyl sulfide. Studies on vesicant-treated tobacco mosaic virus indicated that vesicant residues were attached to both the nucleic acid and protein moieties of the virus.

867 The Reaction of Some Radioactive Mustard-type Vesicants with Purified Proteins, by John L. Wood, Julian R. Rachele, Carl M. Stevens, Frederick H. Carpenter, and Vincent Du Vigneaud. Journal of the American Chemical Society 70, p. 2547-2550, July 1948.

A method is described for the synthesis of the mustard-type vesicants, benzyl β-chloroethyl sulfide and n-butyl β-chlorethyl sulfide containing radiosulfur. Studies were made of the reaction of these radioactive vesicants with three highly purified proteins: insulin, pepsin and tobacco mosaic virus.

868 Factors Affecting Fixation of Phosphorus in Soils as Determined with Radioactive Phosphorus, by J. R. Neller and C. L. Comar. Soil Science 64, p. 379-387, 1947.

Nine different soil samples were extracted with a sodium acetate – acetic acid solution, after being previously treated with KH_2PO_4 plus P^{32} as Na_2HPO_4. The amount of P retained was not affected by the method of drying. Soils treated with soluble P, dried, and extracted showed greater P fixation than when the phosphate was added in the extracting solution. The amount of P retained by soils after treatment with a sodium acetate – acetic acid solution containing 50 ppm of P was related to their clay content.

869 Inhibition of Cleavage and P^{32} Uptake in Arbacia by D-Usnic Acid, by Alfred Marshak and Jane Harting. Journal of Cellular and Comparative Physiology 31, p. 321-325, June 1948.

Experiments are described which were designed to obtain some information as to the possible mode of action of d-usnic acid. The compound had been previously found to have antibiotic properties against tubercle bacilli. The results indicate a marked inhibition of cleavage and P^{32} uptake with little effect on oxygen consumption of fertilized eggs of Arbacia. The manner in which the inhibition is produced remains to be investigated.

TRACER APPLICATIONS, RADIOACTIVE

870 Radioactive Localization of Brain Tumors. Journal of the American Medical Association 137, p. 1228-1229, July 31, 1948.

A radioactive derivative of fluorescein (sodium diiodofluorescein) was synthesized with I^{131}. The amount of I^{131} added was adjusted to give 1 millicurie of radioactivity per 10 cc of a 2 per cent solution of the fluorescent dye. An amount of dye calculated to give 500-600 microcuries of radioactivity was injected intravenously into 12 patients with suspected brain tumors. Counts were taken for three to five minute intervals at each of several positions on the skull with the cone of the detection unit directly on the skin. A definite area was outlined on the skull over the apparent site of the radioactive tissues.

In all cases this outline coincided closely with the extent of the superficially situated meningeoma subsequently found at operation. In 3 cases the preoperative clinical diagnosis was proved wrong. In one negative radioactive test no tumor but an aneurysm of the right internal carotid was found on operation. In a second case the preoperative diagnosis of subdura hematoma was changed to that of tumor by the radioactive test. The radioactive diagnosis was in all cases confirmed by the subsequent operation. Preliminary experiments utilizing induced brain tumors in mice have revealed a concentration of the radioactive dye in tumor tissues as high as eighty times that found in the adjacent normal tissues.

871 Relations between Iron and Cellular Metabolism, by J. L. Rivier and H. Moginier. Helvetica Medica Acta 14, p. 458-461, 1947.

Radioactive iron is stored to a lesser extent in a red rabbit muscle stimulated faradically for 20 minutes after the Fe injection, than in the non-stimulated control muscle. If a muscle is stimulated after one single Fe injection for 2 hours daily during 3 weeks, more radioactive Fe is found in the stimulated than in the control muscle. In rabbits, exposed after the Fe injections for 3 hours to a simulated altitude of 6000-7000 meters, the liver, the heart, and the red skeletal muscles store considerably less Fe than the same organs of the control animals, while more Fe is stored in the spinal cord. Radioactive iron was somewhat lower in the blood of the exposed animals than in the controls. Rabbits given daily altitude exposures for 20 days after one single Fe injection showed more radioactivity in the blood than did the controls and the difference for liver and spinal cord was much larger than for animals with a single exposure. Repeated exposure had about the same effect as a single exposure for other organs.

872 Studies in Intermediary Metabolism Conducted with the Aid of Isotopic Tracers, by DeWitt Stetten, Jr. Bulletin of the New York Academy of Medicine 24, p. 87-96, February 1948.

The powers and limitations of isotopic tracers are discussed and illustrated by several studies made by F. Knoop, M. E. Chaikoff, S. Gurin, G. E. Boxer, and the author. The author concludes that the unanswered questions which will be brought to the surface by the isotope technique will exceed in number the problems that it will solve.

TRACER APPLICATIONS, RADIOACTIVE

873 A Study of the Exchange of Nickel in Certain Complex Compounds Using Radioactive Nickel, by J. Enoch Johnson and Norris F. Hall. Journal of the American Chemical Society 70, p. 2344-2348, July 1948.

The nickel exchange of ten nickel coordination compounds was studied using Ni^{63} as the tracer. In the main the results, which are discussed in detail, show a satisfactory correlation with predictions of bond type based on other criteria.

874 The Turnover of Phosphate in the Pineal Body Compared with that in other Parts of the Brain, by U. Borell and A. Orstrom. Biochemical Journal 41, p. 398-402, 1947.

The phosphate metabolism in 19 different parts of the brain of rats has been measured with radioactive P. The pineal body showed the highest activity being 3-4 times higher than that of the pituitary gland and choroid plexus. A low activity was found in the remaining parts of the brain. All parts of the brain have a higher specific activity 40 minutes after injection with the radioactive P than 145 minutes and 24 hours after. The pineal body is responsible for the high phosphate turnover.

875 Use of Radioactive Iodine in the Study of Thyroid Function in Man, by E. B. Astwood and M. M. Stanley. Western Journal of Surgery, Obsterics and Gynecology 55, p. 625-639, December 1947.

A study was made to determine whether a practical method could be developed for the diagnosis of borderline cases of hyperthyroidism and hypothyroidism, for the study of simple goiter, and for the study of antithyroid compounds. I^{131} was used, with no carrier iodine added, in doses of 0.1 millicurie.

The quantity of ordinary iodine in the body fluids must be very small if an appreciate quantity of the radioactive iodine is to accumulate in the thyroid gland. It is shown that the iodide concentrating mechanism of the thyroid is inhibited by thiocyanate, so that the ratio of the iodide concentration within the thyroid to that in the blood and tissues is caused to approach unity.

In 4 cases of hypothyroidism the rates of accumulation of radioactive iodine in the thyroid were very slow; similar low figures are obtained with normal subjects after the administration of large doses of iodine. In 7 cases of hyperthyroidism the gradients were all higher than the average in normal subjects, but 3 of the normal subjects had gradients in this range and 1 was found to have a rate of uptake faster than in 6 of the 7 thyrotoxic patients. The place of radioactive iodine in the diagnosis of diseases of the thyroid gland is not yet determined, but its place in the study of the function of the gland is well established.

TRACER APPLICATIONS, RADIOACTIVE

876 **The Use of Radiophosphorus, P^{32}, to Measure Phosphorus Utilization by Laying Hens, by J. W. T. Spinks, J. B. O'Neil, J. R. Jowsey, C. C. Lee, and Marguerite Reade. Canadian Journal of Research 26 D, p. 163-176, June 1948.**

Phosphorus utilization in four laying hens has been studied by means of radiophosphorus (P^{32}), which was incorporated into the laying mash as tricalcium phosphate replacing the bone meal in the diet. The results obtained indicate that: the phosphorus that was absorbed appeared in the yolk, white, and shell within 24 hours after feeding; the maximum recovery of P^{32} following a single feeding was within 24 hours in the case of the shell, 48 to 72 hours for the white, and 144 hours (six days) for the yolk; a large portion of the unabsorbed phosphorus was excreted within 24 hours of feeding; a considerable quantity of the phosphorus absorbed by the digestive system was found to be stored in the tibia at least 40 days after feeding; the percentage uptake of phosphorus from tricalcium phosphate rose gradually in the egg and became relatively constant in about 14 to 15 days after the first feeding of tricalcium phosphate.

877 **The Use of S^{35} in the Measurement of Transfer Constants, by Cheves Walling. Journal of the American Chemical Society 70, p. 2561-2564, July 1948.**

A convenient method for the synthesis of radioactive mercaptans from zinc sulfide containing S^{35} has been worked out. The transfer constants of n-butyl mercaptan with styrene, methyl methacrylate, methyl acrylate and vinyl acetate have been measured using radioactive mercaptan, and the advantages of tracer methods in polymer chemistry are discussed.

The results are shown to indicate that ionic forms in the transition state, similar to those involved in radical addition reactions, may be important in determining reactivity in radical displacement reactions.

TRANSURANIC ELEMENTS

878 Isolation of Curium, by L. B. Werner and I. Perlman. AECD-2148 (BC-74), August 9, 1947, decl. September 25, 1947. 2 p. For oral presentation before the meeting of the American Chemical Society in New York City, September 1947.

This is not an abstract; the text of the document is reproduced below in its entirety.

Curium, the fourth of the transuranium elements, has recently been isolated by L. B. Werner and I. Perlman. The isotope involved is the intensely alpha-active isotope, Cm^{242}, of five months half-life. The curium was prepared by the irradiation in a high flux pile of a small amount of 500-year Am^{241} which had previously been isolated by B. B. Cunningham, L. B. Asprey, and D. C. Stewart. Through the nuclear reactions,

$$Am^{241}\ (n,\gamma)\ Am^{242}$$

$$Am^{242} \xrightarrow[18\ hrs.]{\beta^-} Cm^{242},$$

a part of the americium was transmuted and by means of ultramicrochemical techniques, the curium was isolated as a relatively pure compound.

The curium was separated from untransmuted americium by the newly developed methods of adsorption with ion-exchange resins. The adaptation of column adsorption to separations of this nature is largely the work of E. R. Tompkins and co-workers of Clinton Laboratories. The difficulty of separating americium and curium is comparable to that of separating neighboring rare earth elements, but this was accomplished with good yield using a resin kindly furnished by the Dow Chemical Company.

With this minute amount of curium in solution it was possible to obtain the absorption spectrum using micro adaptors on the spectrophotometer. The spectrum is of great interest in regard to the actinide hypothesis for the heavy elements since, according to this theory, curium, like gadolinium, should not absorb light in the visible spectrum. Through analogy with gadolinium, one would expect to find little or no absorption here presumably because of the stability associated with the closed half-shell of seven "f" electrons. This prediction has been amply verified with this sample of curium, which showed strong absorption in the ultraviolet region but none from about 450 - 1100 mμ.

879 Formation of the 50-Year Element 94 from Deuteron Bombardment of U^{238}, by J. W. Kennedy, M. L. Perlman, E. Segre, and A. C. Wahl. AECD-2156 (ANL-JJK-14B-147), June 1942, decl. July 23, 1948. 6 p. For publication in NNES.

It is shown by bombardment with deuterons of a sample of U^{238}, greatly depleted in U^{235} and U^{234}, that the 50-year 94 activity and 2.0-day 93 activity are formed in approximately the same yield as with the natural mixture of uranium isotopes. These activities are thus shown to arise from the U^{238} nucleus, and from considerations of the energy of the compound nucleus (U^{238} +d), it appears most probable that they are produced by a (d,2n) reaction as follows:

$$U^{238}\ (d,2n)93^{238} \xrightarrow[2.0\ day]{\beta^-} 94^{238}.$$

URANIUM

880 The Volumetric Assay of Uranium Tetrafluoride, by N. H. Furman and G. P. Haight, Jr. AECD-2155, May 1947, decl. July 21, 1948. 12 p. For publication in NNES.

It is shown that uranium tetrafluoride may be dissolved in a mixture of boric acid and sulfuric acid without attacking the residue, that is ordinarily reported as oxalate-insoluble material, in nearly pure preparations of uranium tetrafluoride. The soluble U(IV) may be titrated with ceric sulfate. An excess of that reagent is added and after warming to dissolve the dioxide, the excess of ceric sulfate is determined. The data are then used to calculate the percentages of uranium tetrafluoride, "dioxide", and uranyl fluoride (by difference). The results compare favorably with other procedures for evaluating nearly pure preparations of uranium tetrafluoride.

881 Basic Nitrates of Uranium, by Barun Chandra Haldar and Guruprasad Basu Choudhury. Science and Culture 13, p. 427-428, April 1948.

The authors have studied the uranyl nitrate—caustic soda system by the thermometric method. The thermometric titration of uranyl nitrate solutions with caustic soda indicates the existence of the basic nitrate $4UO_2(NO_3)_2UO_2(OH)_2$ in the concentration range 0.02912 to 1.1648 M uranyl nitrate. The uranates $Na_4U_7O_{23}$ and Na_2UO_4 are indicated in the temperature-concentration curves. Other physical methods do not indicate the formation of the uranate Na_2UO_4.

It is concluded that the thermometric method indicates not only the existence of known basic nitrates and uranates as observed by other physical methods but also give clear indications of the formation of the normal hydroxide $UO_2(OH)_2$ and the uranate Na_2UO_4.

882 The Initial Ionization Produced by Fission Fragments, by D. West. Canadian Journal of Research 26A, p. 115-127, May 1948.

The ionization produced by individual fission fragments over various lengths of track starting from the origin was measured in a pulse ionization chamber provided with a grid. The distribution of electron pulse sizes for the complete track showed the well known two peaks. As the length of track was diminished, the peaks corresponding to the high and low energy groups of fragments approached each other and merged together at a track length of about 6 mm in nitrogen. In smaller distances measured from the beginning of the track the difference in ionization by the two groups of fragments was found to be small, and the two groups could not be resolved. From the progressive change in shape of the pulse spectrum it is tentatively concluded that the low energy group produces the greater initial ionization. The average energy spent in ionization by the fragments in the first 1.1, 2.3, and 5.3 mm of their tracks was measured in nitrogen and found to be 7.6, 15.0, and 34.6 Mev respectively. In the course of this work an effect due to the formation of negative ions by electron attachment was observed in the chamber filled with argon. Examination of this effect suggest that, at high collecting fields, formation of negative ions, perhaps in impurities such as oxygen and water vapor, is more pronounced in argon than in nitrogen.

X-RAYS

883 An X-Ray Glancing Angle and Back-Reflexion Camera, by J. L. Howarth. Journal of Scientific Instruments and of Physics in Industry 25, p. 231-234, July 1948.

A glancing angle and back-reflection camera, with an oscillating table for the specimen, is described. The camera was designed for general purposes, particularly identification work, the glancing angle camera being intended to give for lump specimens as good a substitute as possible for a powder photograph. It was important to make provision for fairly large and awkwardly shaped specimens. The relative merits of various forms of film and specimen movement are discussed.